WEST ISLES FEASIBILITY STUDY

A STUDY TO ASSESS THE FEASIBILITY OF
ESTABLISHING A NATIONAL MARINE PARK
IN THE WEST ISLES AREA OF
THE BAY OF FUNDY, NEW BRUNSWICK

TASK REPORT

Parks Canada Parcs Canada
Tourism New Brunswick Tourisme Nouveau-Brunswick

TRANSPORTATION ANALYSIS

WEST ISLES FEASIBILITY STUDY

TRANSPORTATION ANALYSIS

for

THE DEPARTMENT OF TRANSPORTATION
PROVINCE OF NEW BRUNSWICK

August, 1985

Prepared by:

Eastern Designers & Company Limited
Engineering Consultants
P.O. Box 613, 115 Prospect Street
Fredericton, New Brunswick E3B 5A6

Fiander-Good Associates Ltd.
P.O. Box 207, 335 Queen Street
Fredericton, New Brunswick
E3B 1B1

F. L. Goddard, P. Eng.

A. D. Fiander, P. Eng.

FOREWORD

The West Isles Feasibility Study was initiated by the federal Minister of the Environment responsible for Parks Canada and the New Brunswick Minister of Tourism in November, 1983. The purpose of the study is to assess the feasibility of establishing a national marine park in the West Isles area of the Bay of Fundy.

The West Isles Feasibility Study is being conducted in three phases. Phase I is an assessment of the technical feasibility of establishing a national marine park in the West Isles area, from the perspective of Parks Canada and Tourism New Brunswick. If Ministers decide to proceed with the study, Phase II would involve extensive public consultation to provide the local public with the opportunity to become directly involved in the process to decide whether or not the West Isles proposal is feasible. The purpose of Phase III would be to analyse the results of the two preceeding phases, and to prepare a final report based on the findings, with recommendations for a future course of action.

In the process of completing Phase I, nine individual studies were conducted to investigate specific aspects of the feasibility assessment, all of which are summarized in the Phase I report. These nine studies include the following:

1. Recommended Resource Management Guidelines
2. Institutional and Administrative Arrangements
3. Optional Visitor Use Concepts
4. Transportation Analysis
5. Tourism Development Plan
6. Socio-Economic Impact Study
7. Historical/Archaeological Concerns and Opportunities
8. Land Ownership Inventory
9. Analysis and Summary of Public Comments

Copies of the above reports are available upon request from the following addresses:

Department of Tourism,
Recreation and Heritage*
P.O. Box 12345
Fredericton, New Brunswick
E3B 5C3
Phone: (506) 453-2624

Parks Canada
10 Wellington Street
Hull, Quebec
K1A 1G1
Phone: (819) 994-2696

* Throughout this report the former title Tourism New Brunswick has been used. The correct title is now the Department of Tourism, Recreation and Heritage.

TABLE OF CONTENTS

Chapter Number	Title	Page Number
1.0	INTRODUCTION	1.1
	1.1 Study Objectives and Scope	1.1
	1.2 Summary of Study Process	1.2
	1.3 Overview of Park Development Options	1.4
2.0	EXISTING TRAFFIC FACILITIES AND ACTIVITIES	2.1
	2.1 Primary Transportation Access Facilities	2.1
	2.2 Nature of Ferry Operations	2.2
	2.3 Existing Traffic Volumes	2.5
	2.3.1 Recent Trends in Annual Volumes	2.5
	2.3.2 Seasonal Traffic Variations	2.8
	2.3.3 Hourly Variations in Peak Day Demand	2.8
3.0	FUTURE TRAFFIC DEMAND	3.1
	3.1 Base Traffic Volume on Letete Ferry Crossing	3.1
	3.2 Base Traffic Volumes on Primary Access Routes to Study Area	3.3
	3.2.1 St. George to Letete (Route 772)	3.3
	3.2.2 Campobello (Route 774)	3.4
	3.2.3 St. Andrews (Route 127)	3.5
	3.3 Park Generated Traffic	3.6
4.0	CAPACITY EVALUATION/IMPROVEMENT REQUIREMENTS	4.1
	4.1 St. George to Letete Access Route (Route 772)	4.1
	4.2 Campobello Access (Route 774)	4.2
	4.3 St. Andrews Access (Route 127)	4.2
	4.4 Letete/Deer Island Ferry Service	4.3
	4.4.1 Evaluation of Demand Levels (for Park Options I, II and III)	4.3
	4.4.2 Proposed Improvements (for Park Options I & II)	4.11
	4.4.3 Capital Cost of Infrastructure (Options I and II)	4.14
	4.4.4 Operations and Maintenance (Options I and II)	4.15

TABLE OF CONTENTS (Cont'd)

Chapter Number	Title	Page Number
	4.5 Deer Island Highways (Route 772)	4.20
	4.6 Summary of Transportation Infrastructure Requirements	4.21
5.0	OBSERVATIONS AND CONCLUSIONS	5.1
	5.1 Observations	5.1
	5.2 Conclusions	5.8

Appendix A

EVALUATION OF BRIDGE/CAUSEWAY FERRY LINKAGE BETWEEN
DEER ISLAND AND THE MAINLAND

A.1 Introduction A.1
A.2 Infrastructure Requirements A.1
A.3 Site Climatology and Environmental Factors A.3

A.3.1 Tidal Climate A.3
A.3.2 Currents and Non-Tidal Drift A.4
A.3.3 Wind Climatology A.5
A.3.4 Deep Sea Wave Climatology A.6
A.3.5 Near Shore Waves A.7
A.3.6 Preliminary Design Wave and Current Data A.7

A.4 Impact on Resource Industry A.8
A.5 Conceptual Highway Design A.10
A.6 Conceptual Breakwater/Causeway Design A.11
A.7 Ferry Operation A.12
A.8 Conceptual Ferry Landing Design A.12
A.9 Conceptual Bridge Structures A.13

LIST OF TABLES

Table Number	Title	Page Number
2.1	Characteristics of Existing Deer Island Ferries Operated by the Department of Transportation	2.3
2.2	Historical Trends in Traffic Levels on the Letete/ Deer Island Ferry Service	2.6
2.3	Portion of the Daily Vehicular Traffic Accommodated on the Letete/Deer Island Ferry during the 0900 Hours to 1830 Hours Time Period	2.9
3.1	Incremental Visitors Generated As a Result of a Marine Park	3.7
3.2	Peak Period Design Day Incremental Traffic Generated As a Result of the Marine Park	3.8
4.1	Ranges of Possible Additional Demand For Ferry Service As a Result of Incremental Park Traffic	4.5
4.2	Potential Two-Way Car Equivalent Demand Levels On Letete Ferry Service For Park Option I	4.6
4.3	Characteristics of A New 24-Car Ferry Vessel	4.12
4.4	Cost Summary for Ferry Improvements Required to Handle Incremental Traffic Generated By a Marine Park (Options I and II)	4.15
4.5	Estimated Annual Operating and Maintenance Costs For the Letete/Deer Island Ferry Service (Options I and II)	4.17
4.6	Summary of Capital Costs Associated with Transportation Infrastructure/Services Provided By The New Brunswick Department of Transportation	4.22

LIST OF FIGURES

Figure Number	Title	Follows Page Number
2.1	External Transportation Facilities	2.1
2.2	Ferry Operations	2.2
2.3	Cars Using Letete Ferry	2.6
2.4	Trucks Using Letete Ferry	2.6
2.5	Total Vehicles on Letete Ferry	2.7
2.6	Traffic on Letete Ferry	2.7
2.7	Deer Island Crossing	2.8
3.1	Letete Ferry Base Traffic Estimates	3.2
3.2	A.D.T. at Campobello Border Crossing	3.4
4.1	Incremental Traffic, Greens Point-Park-(Option I)	4.1
4.2	Total Traffic to Greens Point-Park-(Option I)	4.1
4.3	Incremental Traffic, Campobello-Park-(Option II)	4.2
4.4	Total Traffic to Park, Campobello-Park-(Option II)	4.2
4.5	Letete Ferry Demand-Option I-Case C	4.6
4.6	Letete Ferry Demand-Option II-Case C	4.8
4.7	Letete Ferry Demand-Options I and II	4.8
4.8	Letete Ferry Demand-Option I-Case D	4.9
4.9	Letete Ferry Demand-Options I and II	4.9

1.0 INTRODUCTION

1.1 Study Objectives and Scope

This report documents work carried out regarding the Transportation Study for the proposed West Isles National Marine Park.

By way of introduction, it is appropriate to provide a general outline of the background associated with the conduct of this study. The basic objective of the study was to evaluate the public transportation infrastructure required to accommodate the potential marine park development, while at the same time minimizing the impact on existing traffic flows and requirements.

Although this study deals only with the public transportation services and facilities which are under the jurisdiction of the New Brunswick Department of Transportation, some elements of the potential park facilities also involve transportation components. Such additional facilities were not addressed in this study.

This work included evaluation of the existing facilities as well as the integration of potential additional traffic which could be generated as a result of a Marine Park. The analysis included all public elements of transportation to the West Isles Park (including the islands and the mainland areas) which would be impacted significantly by the potential Marine park facilities. This included access along the existing highway system (Route 772) between St. George and Letete. Major emphasis was placed on the primary contraint in the transportation network (ie. the ferry link between Deer Island and Letete). As well, consideration was given to access to Campobello Island. General access possibilities included consideration of highways, causeways, bridges, ferries (both self-propelled and cable) and the associated marine structures for such potential ferry services.

1.2 Summary of Study Process

A critical factor which initially affected the conduct of this study was the uncertainty as to the nature and character of the possible park development options and the impact that these factors would have on the potential demand for transportation services. More importantly, during the early stages of this analysis, the geographical distribution of park facilities was not clearly identified. These factors were extremely important, particularly with regard to identification of the relative functions to be located on the major land masses in the proposed park area. In particular, there was need to know the extent and nature of potential park development on the mainland in the Letete/Greens Point area. Of greater importance, it was necessary to know the nature and extent of possible park development on both Deer Island and Campobello Island. As well, the initial elements of our work included consideration of the possibility that certain types of park functions might be proposed on McMaster Island. This latter aspect of the initial work program subsequently became redundant because the park development options which eventual were formulated excluded such features on McMaster Island. Furthermore, the final park development options formulated were not of a nature to necessitate consideration of bridges and/or causeways for access to Deer Island. However, since a substantial amount of effort had been expended on this topic, the material relating to these higher level mainland linkages has been included as Appendix A to this report.

The key factors noted in the above paragraph are those relating to establishing the nature and demand of transportation facilities to the West Isles Study Area. The primary need for input on these questions related to identifying traffic generated by the park facilities at the various subcomponents of the park. Once the characteristics of the park, in terms of the general geographic location of the major subcomponents, were established, it was possible to estimate the traffic impacts and assess associated infrastructure requirements.

Our initial review was completed while work was simultaneously being carried out by Parks Canada/Tourism N.B. regarding clarification of the potential development concepts for the Marine Park. Of equal importance as input to our work was the work done for Parks Canada by the DPA Group relating to the visitation demand forecasts for the park development options.

Our initial review of traffic activity indicated that the existing primary ferry service to Deer Island at Letete was operating essentially at capacity during the peak summer period. Evaluation of transportation requirements necessitated superimposing potential park related traffic on the base level of demand associated with existing activities. However, it was impossible to pursue this task with any degree of accuracy without additional information relating to the nature of potential park development options. More importantly, it was necessary to have input regarding potential visitations to the different geographical components of the park for the various development options being proposed. Therefore, after discussions with the Transportation Steering Committee regarding this topic, the Transportation Study was postponed until more detailed information was available regarding the nature of park development and associated visitations. Consequently, the initial phases of the Transportation Study terminated in the Spring of 1984. No further activity on the Transportation project was carried out until after the park visitation forecasts prepared by the DPA Group were made available late in 1984. The Transportation Study described in this report was reactivated in early 1985. Work subsequent to that time involved analyzing the impact the park visitation levels identified in the DPA report would have on the transportation infrastructure. This analysis also incorporated consideration of the growth in normal (base) traffic levels which would occur irrespective of park development. Subsequent to the client's review of our initial draft report, a third park development option was identified and its transportation requirements evaluated.

The DPA Group park visitation estimates for the three basic park development options were used as input to our analysis. The DPA Group report also provided a breakdown of the visitations associated with these park development options for the major geographic areas of concern. The DPA Group report identified potential demand at the Letete/Greens Point area as well as at the Campobello Island component of the park. Similarly, they prepared estimates of the visitation to the West Isles/Deer Island component of the park. The information provided in the DPA Group report enabled evaluation of the demand that would be generated by the marine park activity. This input also provided an opportunity to identify the approximate level of incremental demand on various major sections of the transportation system.

1.3 Overview of Park Development Options

The three park development concepts are described as Options I, II and III. These portray a potential marine park in a rural setting with a relatively low level of community infrastructure. The park emphasizes the aquatic environment integrating the local folklore with boat tours, scuba diving and a variety of aquatic activities. The primary differences between the three options are the geographic location of the various facilities and services which constitute the park infrastructure.

Option I would result in the marine park being concentrated on the mainland portion of New Brunswick in the Greens Point area near Letete. This option would include an information and orientation function provided at St. George. Primitive camping would be provided on some of the smaller islands in the West Isles archipelago.

Option II is a more decentralized concept providing for a greater dispersion of the recreation opportunities throughout the proposed marine park area (ie. on the mainland at Greens Point, Campobello, Deer Island).

Option III consists of a level and type of services and facilities similar to Option I and II. However, the geographic distribution of these services is somewhat different. For Option III, visitor services would be provided at two major locations; St. Andrews and Campobello Island.

The primary features of each of the three park development options can be summarized as follows:

Option I

- The primary land base for the proposed National Park is at Greens Point.

- This option would not provide any facilities on Deer Island.

- The major visitor activity area located at Greens Point would include a visitor centre, parking, picnicing, dive centre, viewing point, boat launch, a major wharf, mooring/docking areas, and a marine observatory. For this option the Park Administration Centre would also be located at Greens Point.

- In addition to provision of the scuba diving areas and shuttle boats for marine observation and interpretive boat tours, this option would provide for limited primitive accommodations (tenting) on some of the small islands between Deer Island and Campobello (eg. Spruce Island and Casco Bay Island).

- The primary point of access for all of the park facilities inherent in this option is along Route 772 between St. George and Greens Point.

- The anticipated number of peak season* visitors for the Greens Point area for Option I is slightly in excess of 15 000 visitors for the base year of it's operation. The estimates provided by DPA indicate that the visitation level would increase to slightly in excess of 38 000 seasonal visitors annually by the tenth year of operation of this park option. These estimates for the peak season (May to October inclusive) are expected to represent about 75 percent of the total annual visitation to the park. Based on these estimates, the total annual visitation to the Greens Point area under Option I would be 20 600 in Year one increasing to about 51 000 in Year ten. Incremental peak season visitation levels are detailed in Table 3.1. Similarly, peak design day incremental vehicular traffic volumes are shown in Table 3.2.

---

* Peak season is defined as the May to October period, inclusive.

Option II

- This option includes small land bases in several decentralized locations including Greens Point on the mainland near Letete, two small parcels of activity on Deer Island (one at Butler Point/Stuart Town and one at Deer Island Point) and two small parcels of activity on Campobello Island (one at Wilson's Beach and one at East Quoddy Head (near Head Harbour)).

- The major difference between Option I and Option II is the fact that for Option II the primary visitor activity centres are located on Deer Island and Campobello rather than on the mainland at Greens Point. These primary visitor activity centres would be at Butler Point on Deer Island and at Wilson's Beach on Campobello. Minor visitor activity centres would also be located at Greens Point, Deer Island Point and East Quoddy Head (near Head Harbour). This option involves an increased level of demand to both Deer Island and Campobello as a result of the location of specific land activity centres on these islands.

- The total peak season (May to October) park demand on Campobello as a result of Option II is estimated to be nearly 13 400 visitors in the initial year increasing to in excess of 73 000 visitors by Year ten. As is the case for Option I, it is anticipated that these peak season visitation estimates for the May to October period represent about 75 percent of the overall annual demand.

- The volume of traffic to Deer Island associated with Option II could be equal to the visitation levels associated with the Greens Point visitor centre in Option I. That is, the peak season visitation for Year one could be 15 400. Although the DPA Group study assumed that this visitation level would remain constant throughout, this is not considered to be realistic for purposes of evaluating traffic impacts on the ferry service. Instead, various potential growth rates in park visitation have been evaluated for the Greens Point facility.

Option III

- This option consists of a level and type of services and facilities similar to Options I and II. However, the geographic distribution of these services and facilities is different from the other visitor use scenarios.

- With Option III, visitor services will be provided at two major locations: St. Andrews and Campobello Island. No visitor services will be provided by Parks Canada on Deer Island, nor in the Back Bay - Letete - Greens Point area.

- Information about the proposed national marine park would be available from the tourist information centre at the western intersection of Route 127 and Route 1. Additional visitor services will be provided in the nearby Town of St. Andrews. Among the facilities available at St. Andrews will be a major visitor centre and tour boat linkages to the proposed national marine park.

- Campobello Island is the other major centre for serving park visitors. General information about the park will be available at the tourist information centre near the Roosevelt-Campobello International Bridge. A variety of visitor services will be provided on a few small parcels of land on the northern shore of Campobello Island, including a dive centre for the convenience of certified scuba divers and special interpretive events.

- incremental visitation levels for Option III for both the St. Andrews and Campobello areas are shown in Tables 3.1 and 3.2.

1.4 Report Format

This introductory chapter has provided an overview of the objectives and scope of this project, outlined a general sequence of activities associated with the conduct of this study and highlighted the nature of park options evaluated. The final analysis summarized in this document is based on the three park development options which were prepared by Parks Canada and Tourism New Brunswick. Furthermore, this analysis of transportation requirements is based on the park visitation estimates which were prepared by the DPA Group.

The remainder of this report describes the results of this analysis of transportation demand, facility requirements and impacts. The following topics are treated in separate chapters:

Section 2.0: Review of existing traffic characteristics (including the Letete ferry activities);

Section 3.0: Future traffic demand evaluation;

Section 4.0: Capacity evaluation;

Section 5.0: Observations and conclusions.

Appendix A: Evaluation of Bridge/Causeway/Ferry Options for Linkage Between Deer Island and the Mainland.

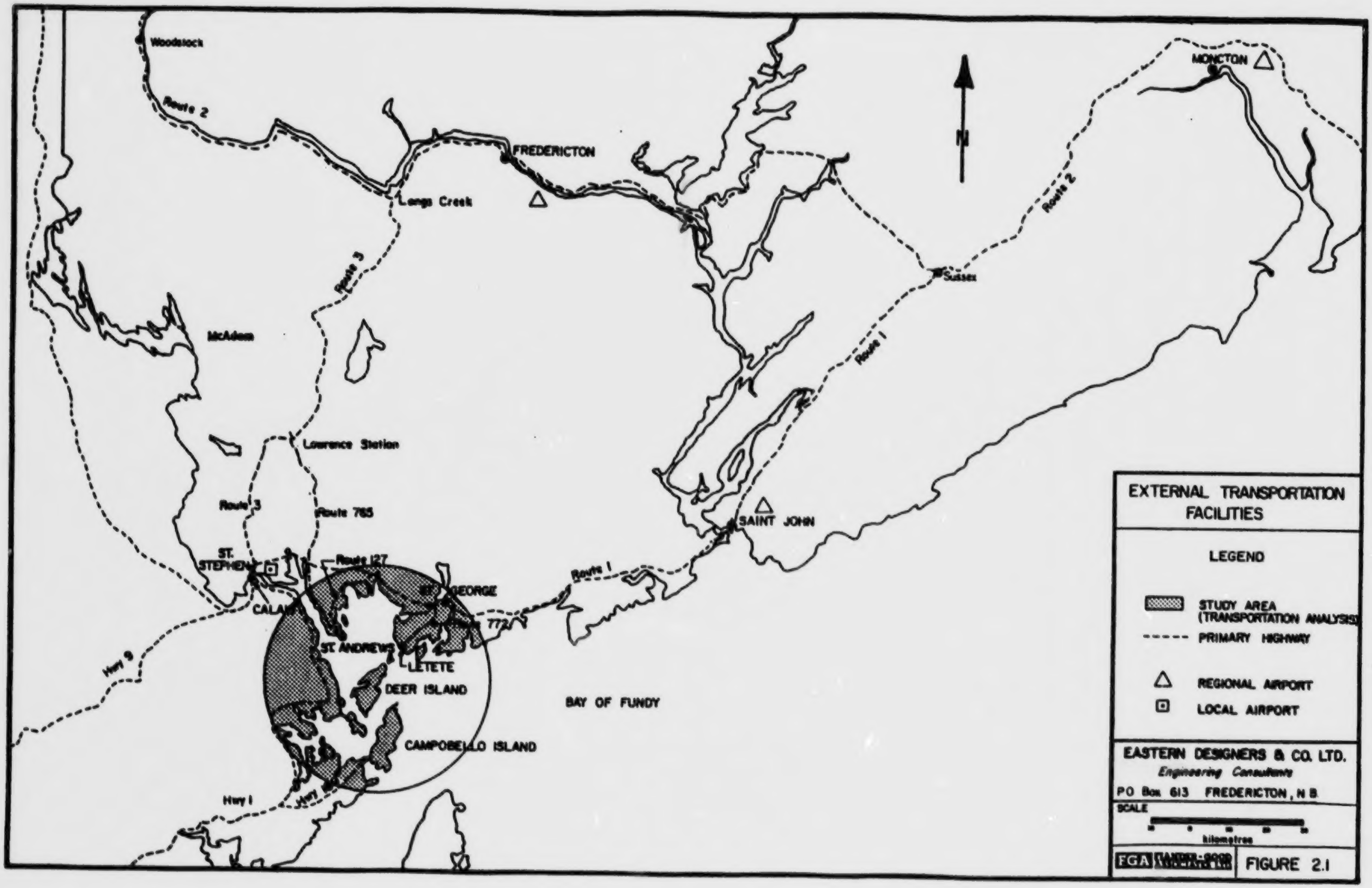
2.0 EXISTING TRAFFIC FACILITIES AND ACTIVITIES

2.1 Primary Transportation Access Facilities

Figure 2.1 provides a general overview of the entire Study Area for this report dealing with Transportation Analysis. This figure illustrates the primary highway access facilities in both New Brunswick and Maine. As can be seen, the major access to the Study Area in New Brunswick for Options I and II is from arterial Route 1 at St. George. The logical access point for the park related traffic would be from the eastern access point at St. George. Traffic should then be routed along the eastern edge of St. George to Letete via local Route 772. Route 772 is characteristic of most local highways in New Brunswick. The surface is paved and is in reasonably good condition although the geometry involves short, relatively steep grades and abruptly changing horizontal alignment with narrow shoulders. Development along this route is not extensive with the exception of the municipal development at the northern terminus in St. George and a short section through the Back Bay area.

The ferry terminal facility in Letete (Matthews Cove) was upgraded in the 1970's. The facility is a simple, dual ramp arrangement on each side of a central wharf structure which forms the ferry berth. Normal traffic levels have not warranted separate vehicle marshalling compounds. The current procedure for assembling vehicles for loading on the ferry is simply to stop traffic along the edge of the approach roadway. A similar ferry terminal facility exists at Butler Point on Deer Island.

The other primary access to the Study Area for Options II and III is that relating to the highway access to Campobello Island from Highway 1 in Maine. This connection is provided by Maine Highway 189 which intersects with Highway 1 at Whiting. Access to Campobello from Maine Highway 189 is achieved via the Roosevelt Bridge at Lubec. The key highway on Campobello Island (local Route 774) is also in typical condition for local highways in the Province of New Brunswick. The quality of the Route 774 facility is


Woodstock
Route 2
FREDERICTON
Longs Creek
Route 3
McAdam
Lawrence Station
Route 3
Route 765
ST. STEPHEN
Route 127
CALAIS
ST. GEORGE
772
ST. ANDREWS
LETETE
DEER ISLAND
CAMPOBELLO ISLAND
Hwy 9
Hwy 1
Hwy 1
Route 1
BAY OF FUNDY
SAINT JOHN
Route 1
Sussex
Route 2
MONCTON
N
LEGEND
STUDY AREA (TRANSPORTATION ANALYSIS)
PRIMARY HIGHWAY
REGIONAL AIRPORT
LOCAL AIRPORT
EASTERN DESIGNERS & CO. LTD.
Engineering Consultants
PO Box 613 FREDERICTON, N.B.
SCALE
kilometres
FGA

EXTERNAL TRANSPORTATION FACILITIES

FIGURE 2.1

relatively consistent from the Lubec Bridge to Wilsons Beach. However, between Wilsons Beach and East Quoddy Head, the road quality deteriorates substantially. In particular, the section from just north of the access road to Head Harbour Wharf is unpaved and in relatively poor condition to handle any significant additional volume of traffic generated as a result of a National Marine Park.

For Option III the primary access requirements would be to Campobello and St. Andrews. Connections between St. Andrews and Deer Island would be by water on facilities other than those operated by the Department of Transportation. Access between St. Andrews and arterial Route 1 is by means of the collector Route 127. This route is functionally in typical condition for routes of this type.

2.2 Nature of Ferry Operations

The primary access (see Figure 2.2) to Deer Island is provided by the Letete Ferry running from Matthews Cove at Letete to Butler Point just north of Stuart Town, Deer Island. This year round free service provided by the Department of Transportation is based on the simultaneous operation of two vessels: The JOHN E. RIGBY and the D.L. MacLAREN.

These vessels operate throughout the year on a schedule which generally provides for half-hour service from both the Deer Island and Letete ends of the crossing. Typically, the service provides for departures on the hour and on the half-hour. The peak season schedule provides for service starting at 6:30 in the morning and terminating at 10:30 in the evening. The primary vessel is the JOHN E. RIGBY and the secondary vessel is the D.L. MacLAREN (see Table 2.1). The JOHN E. RIGBY has a capacity of 17 cars and the D.L. MacLAREN has a capacity of 12 cars. The JOHN E. RIGBY also has the capacity for 30 foot passengers and the D.L. MacLAREN has the capacity for 15 foot passengers. These foot passenger capacities are for those in addition to the passengers who would normally be associated with the vehicular traffic. Both vessels have a main deck breadth which allows for three lanes of vehicles. The JOHN E. RIGBY is a newer vessel having been built in 1976. The D.L. MacLAREN is now 30 years old and is reaching the end of it's useful life.

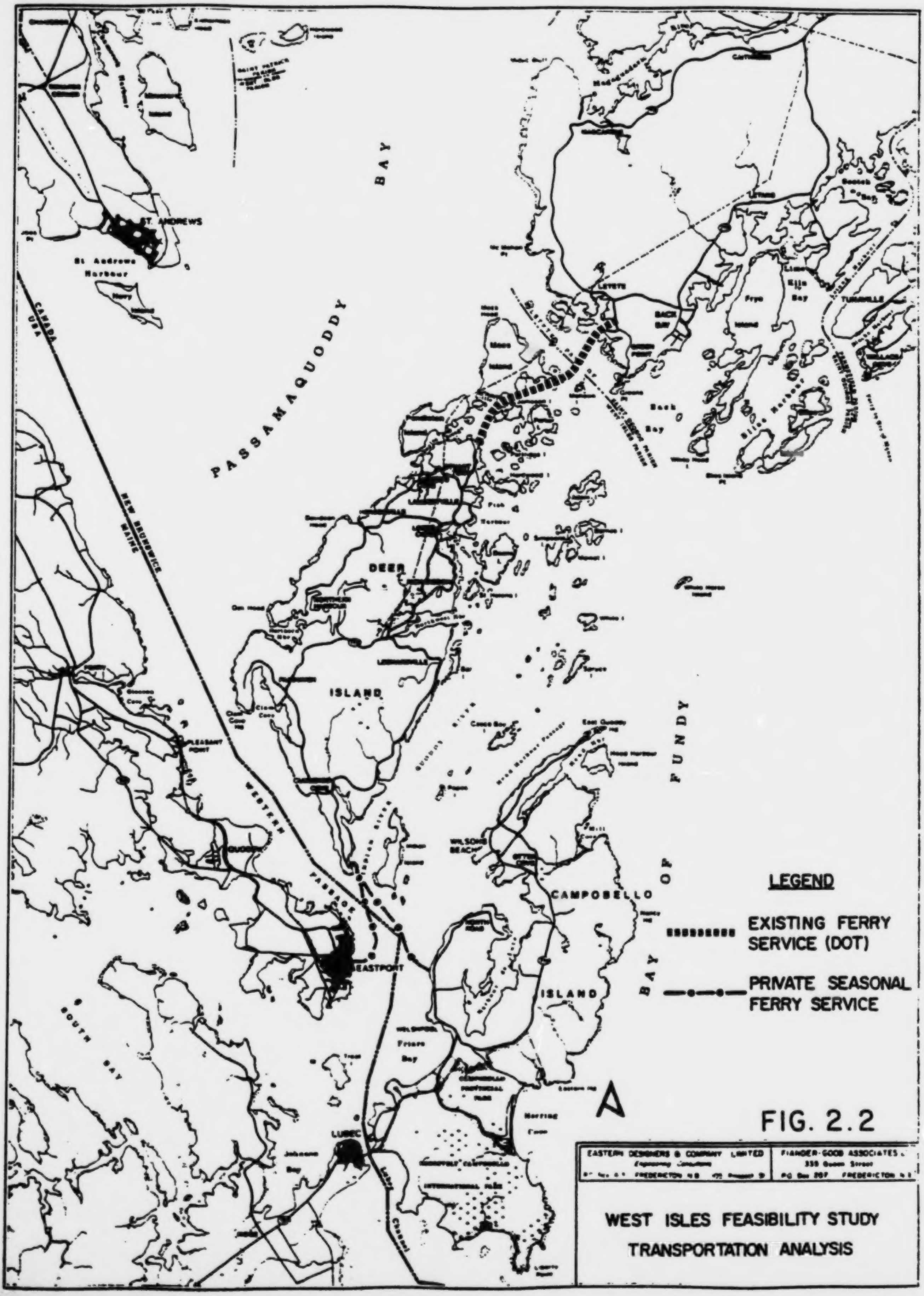

PASSAMAQUODDY BAY
ST. ANDREWS
St Andrews Harbour
Navy Island
CANADA
USA
NEW BRUNSWICK
MAINE
LETETE
BACK BAY
Back Bay
Frye Island
Fish Harbour
DEER ISLAND
Cloam Cove
PLEASANT POINT
WESTERN PASSAGE
WILSONS BEACH
CAMPOBELLO ISLAND
BAY OF FUNDY
EASTPORT
Friars Bay
SOUTH BAY
Johnson Bay
LUBEC
Herring Cove
LEGEND
EXISTING FERRY SERVICE (DOT)
PRIVATE SEASONAL FERRY SERVICE

FIG. 2.2

EASTERN DESIGNERS & COMPANY LIMITED
Engineering Consultants
FREDERICTON N.B.

FIANDER-GOOD ASSOCIATES
339 Queen Street
P.O. Box 207 FREDERICTON N.B.

WEST ISLES FEASIBILITY STUDY
TRANSPORTATION ANALYSIS

Table 2.1

Characteristics of Existing Deer Island Ferries Operated by the Department of Transportation

	Vessel Name	
Item	John E. Rigby	D. L. MacLaren
Year Built	1976	1955
Length of Hull (m)	32.0	27.4
Length (including ramps (m)	42.4	28.3
Breadth of Main Deck (m)	11.9	11.0
Depth (m)	2.4	2.4
Draft (unloaded in m)	1.4	1.2
Capacity (cars)	17	12
Foot Passenger Accommodations	30	15
Net Tons	227	134
Hull Type	Steel	Steel
Type of Engine	2-371 HP GM Diesel	Twin 6 Cylinder Diesel

The general physical characteristics of the vessels are sufficiently similar that the terminal facilities can accommodate both vessels. The vessels have unloaded drafts of 1.2m and 1.4m respectively.

The ferry service between Deer Island Point and Eastport and that between Deer Island Point and Welshpool, Campobello is provided by a private operator. These services are operated only during the summer months. Typically, the services start on the July 1 weekend with the Campobello run terminating on Labour Day. The Eastport ferry operates until late in September. The two ferries operating out of Deer Island Point involve a fishing boat lashed alongside a large scow. The scows are used to transport the vehicles with the fishing boat acting essentially as a tug boat. The terminal facilities at both Deer Island Point and Welshpool are limited to a few piles driven in a line along the beach so the vessel can lay alongside while loading and unloading vehicles. There is no ramp structure at either location nor is there a ramp structure at the Eastport end. For all three terminals relating to the private ferry services from Deer Island Point, the beach is used as the loading ramp.

Indications are* that the inter-island ferry service from Deer Island Point and Welshpool has a one-way utilization of approximately 2 000 vehicles per season. Assuming an average vehicle occupancy of 2.5 persons, this is equivalent to about 5 000 persons. It is estimated that the Deer Island to Eastport service would probably accommodate a slightly larger volume each way during the peak season. Given the existing vessel configurations on these two services from Deer Island Point (ie. to Welshpool and Eastport) it is unlikely that the volume of traffic which could be accommodated would increase substantially because of the fact that the service is currently operating about at capacity.

---

* "Proposed West Isles National Marine Park, Socio-Economic Impact Study", The DPA Group, March, 1981, p. 151.

2.3 Existing Traffic Volumes

2.3.1 Recent Trends in Annual Volumes

The volume of activity on the Letete/Deer Island ferry service for the last several years is summarized in Table 2.2. This table indicates the total number of one-way trips made by the combined services of the JOHN E. RIGBY and D.L. MACLAREN. The table also indicates the number of cars (including half-ton trucks), the number of trucks, the sum of cars and trucks, and the total number of passengers. As well, an estimate of the equivalent number of passenger car spaces is provided based on an assumed ratio of 2 car spaces per truck.

Figures 2.3 to 2.6 summarize some of the critical information contained in Table 2.2.

Figure 2.3 illustrates the total number of cars crossing the Letete/Deer Island Ferry Service from 1977/78 until 1982/83. This plot indicates there was growth in the volume of cars until 1979 with a decline subsequent to that point in time. The approximate equivalent rate of growth throughout the six-year period illustrated in Figure 2.3 results in an average annual compound rate of growth in car traffic of about 1 percent.

Figure 2.4 provides similar information relating to the number of truck units utilizing the Letete/Deer Island ferry service. This particular figure is especially important since it indicates the importance of the ferry service to the local economy - the mainstay of the island economy being the fishing industry. It is evident that although there has not been substantial overall growth in truck traffic from one year to the other, it is, nevertheless, important to note that the truck traffic (which is obviously associated with the island business/industry) has been increasing steadily throughout this period. The information illustrated in Figure 2.4 results in a significant growth relationship for the truck

Table 2.2

Historical Trends in Traffic
Levels on the Letete/Deer Island Ferry Service

Fiscal Year	Trips*	Cars**	Trucks	Cars & Trucks	Passenger Car Equivalents***	Passengers
77/78	14 801	68 504	17 387	85 891	103 278	200 616
78/79	13 887	71 843	19 139	90 982	110 121	203 069
79/80	15 418	77 541	21 974	99 515	121 489	215 208
80/81	16 153	74 487	23 564	98 051	121 615	214 827
81/82	15 879	73 277	24 785	98 062	122 847	219 814
82/83	15 211	71 763	26 204	97 967	124 171	223 203

* These figures are the combined totals for one-way trips by the two ferry vessels.

** Figures in this column include half-ton trucks.

*** The passenger car equivalents are based on applying a factor of 2.0 to the number of trucks.

FIGURE 2.3
CARS USING LETETE FERRY

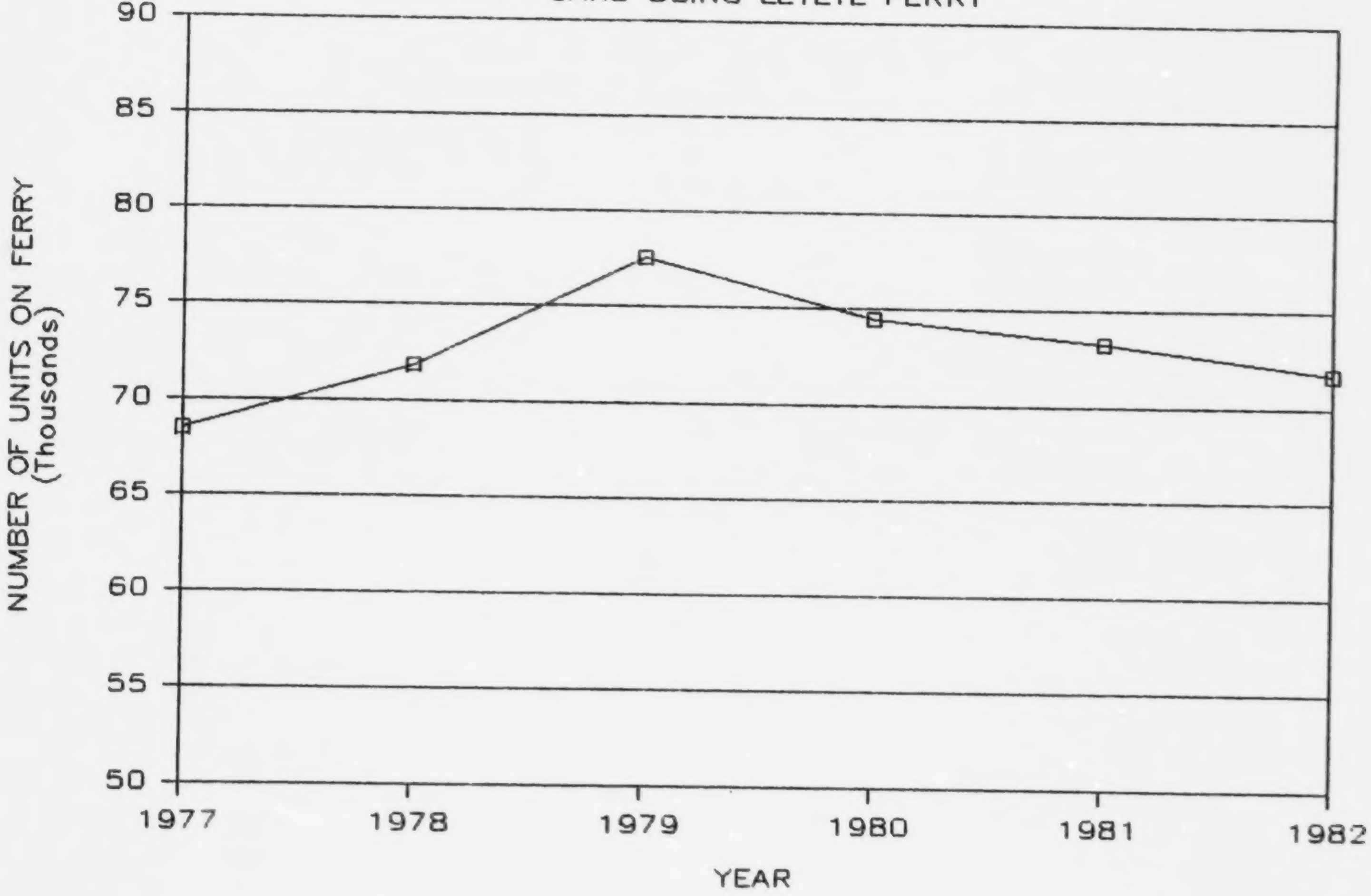
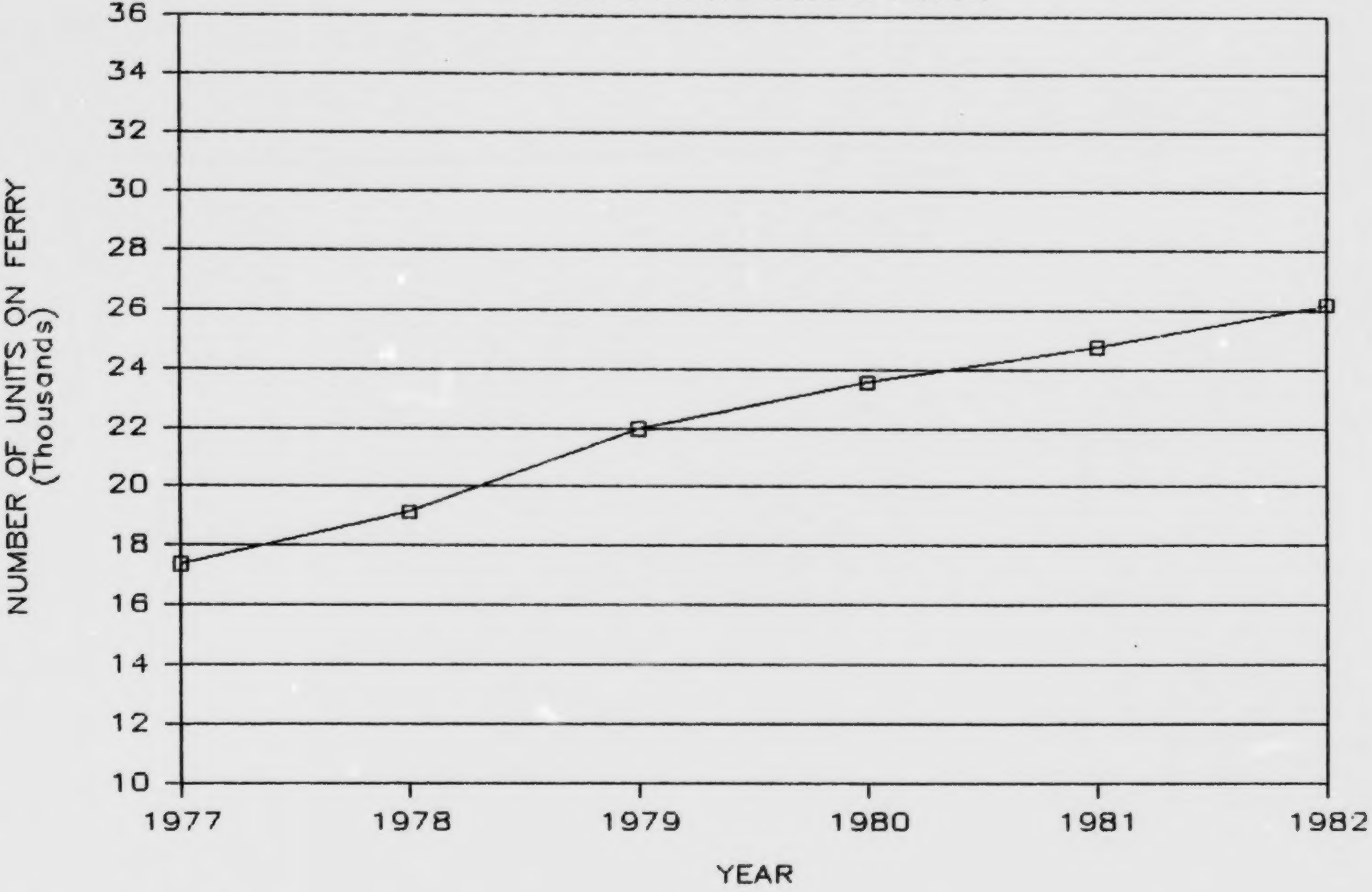


FIGURE 2.4

TRUCKS USING LETETE FERRY



units. The resulting net growth rate over the six-year time period illustrated in Figure 2.4 is equivalent to about 8 1/4 percent per year.

Figure 2.5 provides a similar plot illustrating the combined totals for cars and trucks during the six-year time-frame under review. The data on total movements of cars plus trucks indicates an effective annual growth rate of about 2.7 percent. However, Figure 2.6 is a more meaningful illustration of the combined total activity levels for cars and trucks. Figure 2.6 shows the total vehicular utilization of the ferry service in terms of passenger car equivalent spaces. This reflects the adjustment necessary to recognize the impact that trucks have on the total demand for space on the vessels.

It is evident from Figure 2.6 that although the total volume of traffic accommodated by the ferry service increased during the late 1970's, the information for the last four years indicates that total passenger car equivalent activity has generally leveled off. However, observing the specific information for the truck component of the total traffic, it is evident that there has been a continued growth in the demand for space on the ferry service by trucks.

Reviewing the data illustrated in Figure 2.6, the overall rate of growth in traffic for the six-year period results in a net combined rate of growth in passenger car equivalent spaces for cars plus trucks of about 3.75 percent per year. This is slightly in excess of the equivalent annual rate of growth of 2.7 percent per year in the total number of actual vehicle units, regardless of whether they are cars or trucks.

The above information is utilized in the following chapter as the basis for estimating the approximate growth which could be anticipated in the base level of traffic associated with the resident and historical visitor activities that have existed and will continue to exist in the Deer Island area. This information will be used as the basis upon which additional incremental traffic associated with the potential park development would be superimposed.

FIGURE 2.5
TOTAL VEHICLES ON LETETE FERRY

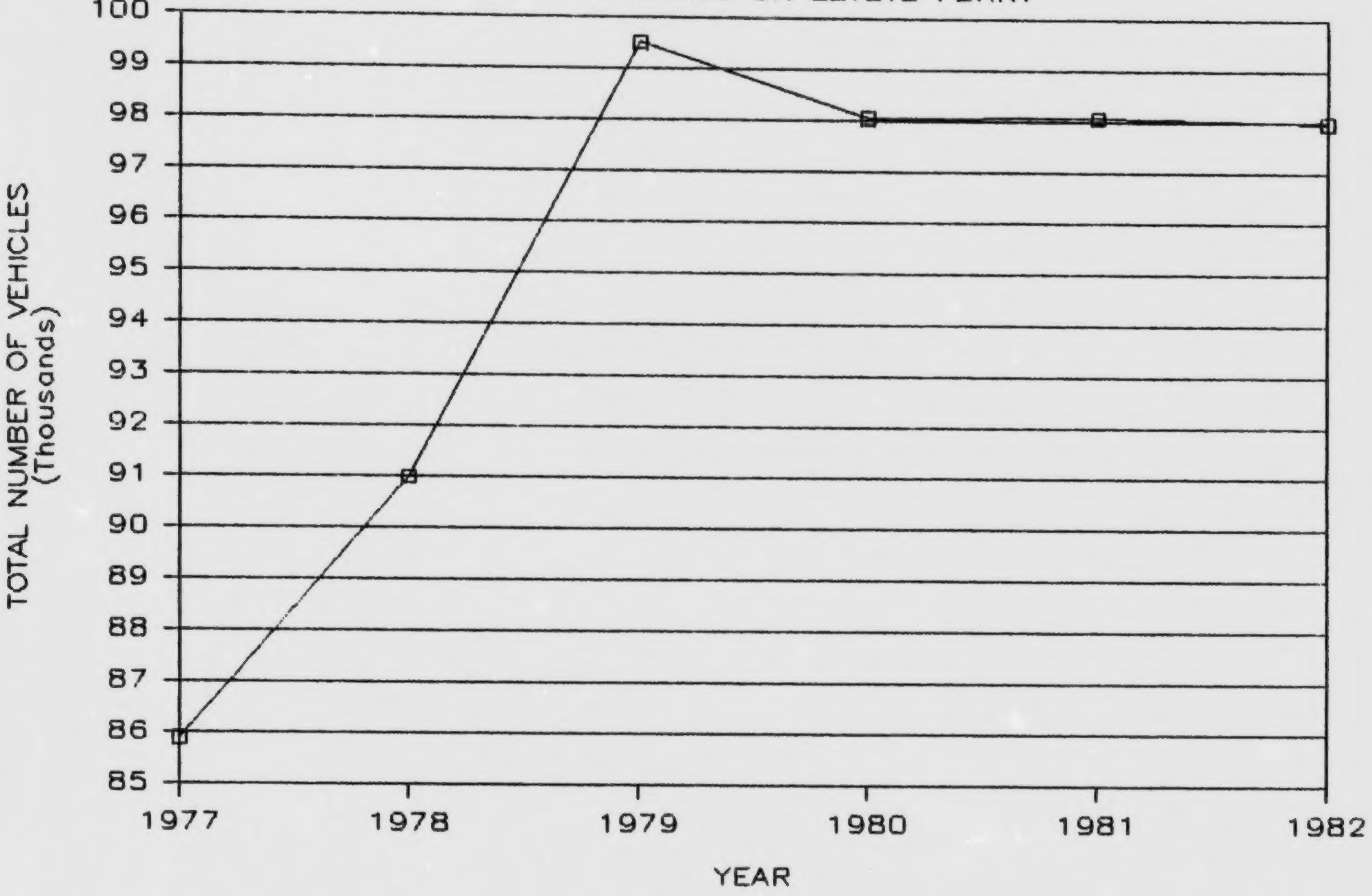
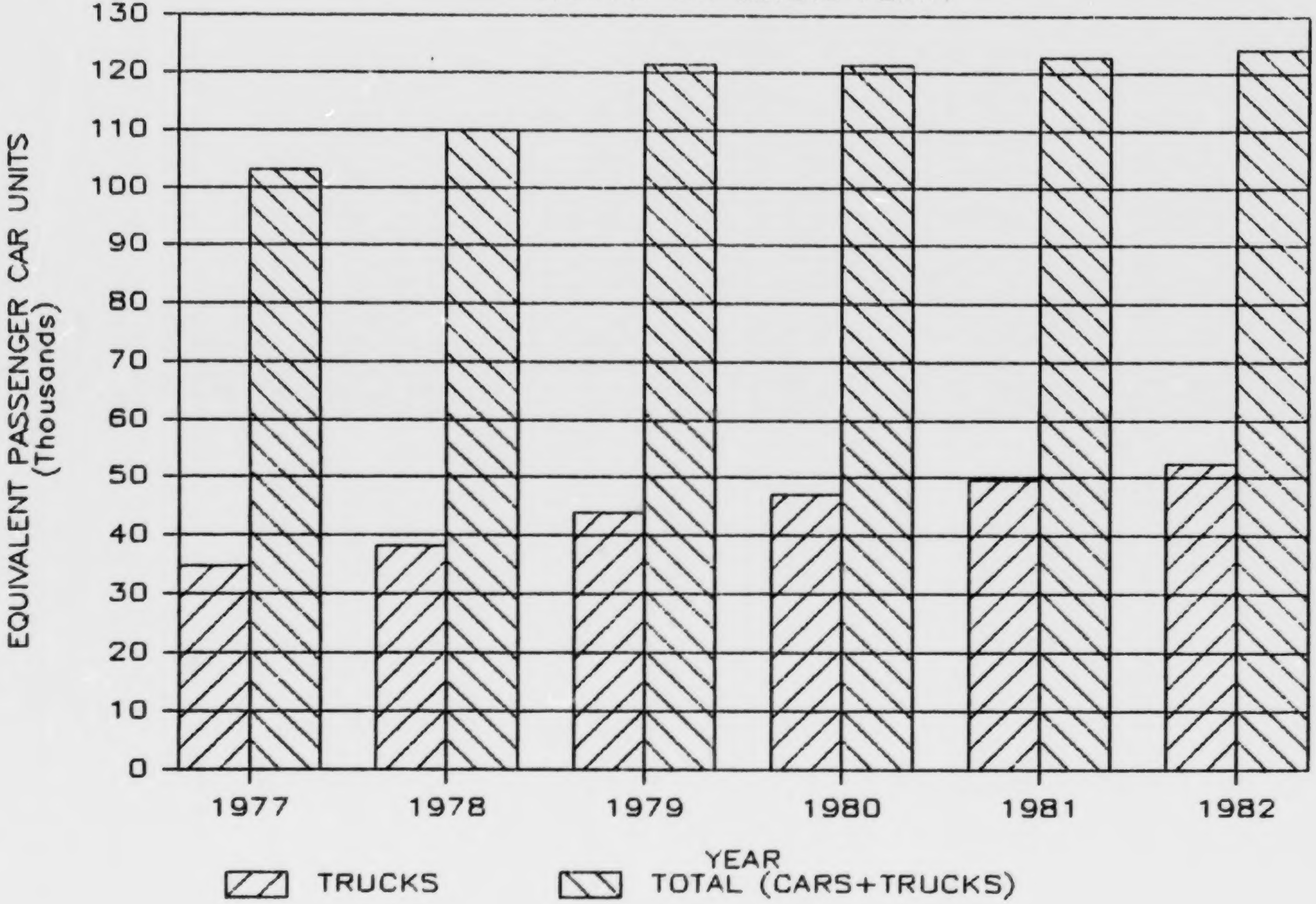


FIGURE 2.6

TRAFFIC ON LETETE FERRY



2.3.2 Seasonal Traffic Variations

Another factor critical to evaluating the capacity of the existing ferry service relates to the extent of variation in the volume of activity throughout the year. Figure 2.7 illustrates the monthly variation for fiscal year 1982 - 1983 for the total one-way movements of a). cars, b). truck passenger-car-equivalents and c). of the total passenger-car-equivalents for both cars and trucks combined. This figure clearly illustrates the extent of demand which occurs during the July and August period. This peaking in the normal base traffic activity also coincides with the anticipated peak activity for the potential marine park.

2.3.3 Hourly Variations in Peak Day Demand

Further evaluation of the peak ferry activity data provided by the Department of Transportation involved examining the details of daily variation for typical peak days within the July/August period. Examination of data for recent years indicated that the third week of July represented activities which were consistent with the peak traffic throughout the two-month primary summer season.

In addition to simply identifying the magnitude of vehicular activity on the existing ferry service for the peak design days during the summer period, specific consideration was given to the variation in demand throughout the day. Although the ferry service is provided from 0630 hours in the morning until 2230 hours at night, it would be unrealistic to assume that the demand is evenly distributed throughout these service hours. Several plots of ferry activity data were made to determine the hourly peaking characteristics within the typical peak days to determine a more detailed picture of the characteristics of demand for ferry service.

Table 2.3 illustrates the percentage of the total passenger car units carried in the peak days of the third week in July during the summer of 1983. This table illustrates that the peak demand for traffic activity

FIGURE 2.7
DEER ISLAND CROSSING

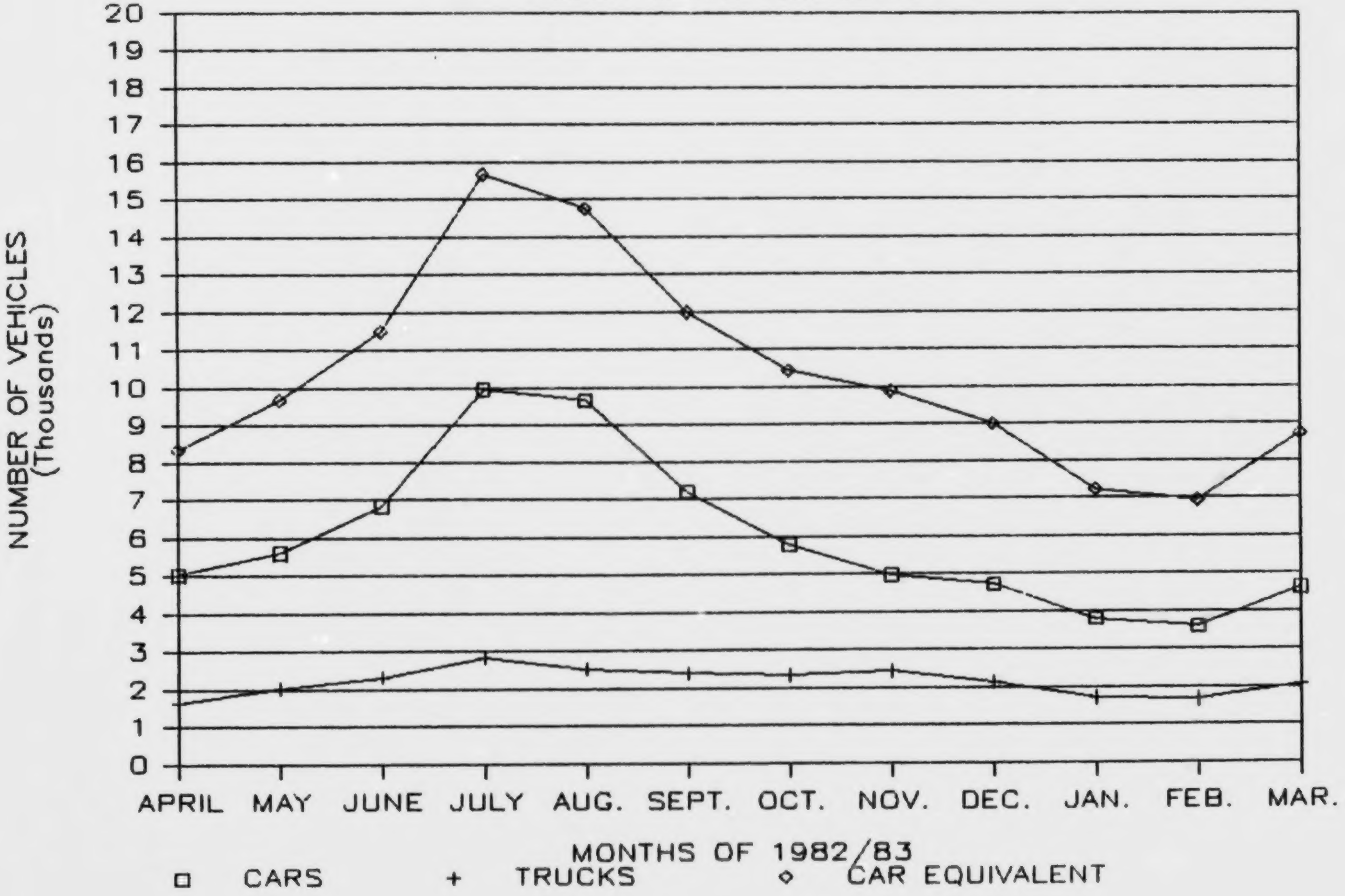


Table 2.3

Portion of the Daily Vehicular Traffic Accommodated on the Letete/Deer Island Ferry During the 0900 Hours to 1830 Hours Time Period*

Day of the Week	Percent of Total Daily Equivalent Car Units Carried in the Given Time Period
Thursday	89.6
Friday	87.7
Saturday	88.8
Sunday	89.2
Average	88.7

* This data is for a peak week (ie. the third week) in July of 1983.

during the peak period occurs between 0900 hours and 1830 hours. Although the existing ferry services operate for a morning and evening shoulder period providing an additional 5 1/2 hours of service, generally about 89 percent of the vehicular traffic is carried during the 9 1/2 hour time period from 0900 hours to 1830 hours. This percentage varies between 87.7 percent of the daily traffic for Friday and 89.6 percent of the daily traffic occuring in this period on the Thursday.

Identification of the 0900 hours and the 1830 hours times for the separation of the peak period within the day was based on detailed plots of the actual number of passenger units carried on each ferry crossing for a four-day period during the peak week of July in 1983. These detailed plots of traffic carried by each ferry departure throughout the day indicated the buildup in vehicular activity during the various hours of the days. Examination of these plots also clearly indicated the fact that during the peak period, both vessels (ie. the JOHN E. RIGBY and the D.L. MacLAREN) are running at full capacity during the greater part of the day. Generally, this is true from about 0930 to 1000 hours until 1700 to 1900 hours.

This analysis also provided an opportunity to evaluate the validity of the ratio of passenger cars equivalents assigned to each truck unit. It might be noted from Table 2.2 that the actual number of trucks has represented 20 to 27 percent of the total vehicles carried by the ferry service based on actual vehicle counts without any consideration of the additional size of trucks in comparison to cars. The 27% value is for the 1982/83 year. It is also interesting to note that this percentage of trucks in the traffic streams has been increasing on an annual basis. This analysis indicated that the ferry service was periodically carrying in excess of the theoretical capacity of typical car spaces if the truck passenger car equivalent of 2.0 is utilized. However, this is counter-balanced by the fact that the current composition of the automobile fleet has resulted in a significant reduction in the average length of car due to an increase in the proportion of small cars in recent years. These two factors counter-balance each other and effectively explain the marginal increase in the number of equivalent vehicles accommodated on some particular ferry crossings during the peak period.

This analysis indicates that the existing ferries are currently operating at full capacity for the majority of the peak summer daily crossings during the 9 1/2 hour period between 0900 hours and 1830 hours.

3.0 FUTURE TRAFFIC DEMAND

3.1 Base Traffic Volume on Letete Ferry Crossing

Detailed evaluation of the existing ferry traffic data for the peak days of 1982/83 indicated that the typical design value for the number of passenger car unit equivalents during the peak design day for the summer of 1983 was about 500 (total in both directions).

The information summarized in Section 2.3 and illustrated in Figures 2.3 to 2.6 inclusively, provided an indication of the growth rate for the various components of the vehicular traffic demand. Depending on the approach taken to the two major components of vehicular traffic (ie. cars and trucks), the growth rate to be utilized for future estimates could vary. Evaluation of the information in Figure 2.3 indicated that the overall equivalent annual growth rate in car traffic was only approximately 1 percent per year. However, as noted earlier, Figure 2.4 illustrates that the growth in truck traffic was slightly in excess of 8 percent per year. This resulted in a combined growth of about 2.7 percent per year for the total number of cars and trucks combined. However, when the approximate passenger car equivalents is applied to the basic data on truck volumes and the information is plotted as summarized in Figure 2.6, the resulting equivalent annual rate of growth for the total number of passenger car equivalents is about 3.7 percent during the five years illustrated in these figures.

For purposes of estimating future traffic demand for the current (non-park) base traffic activity, it should be recognized that there are implicit limits which realistically apply to the provision of ferry service operations. This relates primarily to the fact that it is not necessarily practical to expect that growth would continue in the long-term at rates which might exist over a relatively short period such as that between 77/78 and 82/83. However, it must be recognized that there is inherently a component of suppressed demand associated with the existing traffic activities. This suppressed demand would probably develop if service improvements were made to accommodate park related traffic. Consequently, a range of potential annual growth rates in the base (existing) traffic activity was considered. The range of equivalent annual growth rates considered for the base traffic which is now utilizing the ferry service was as follows:

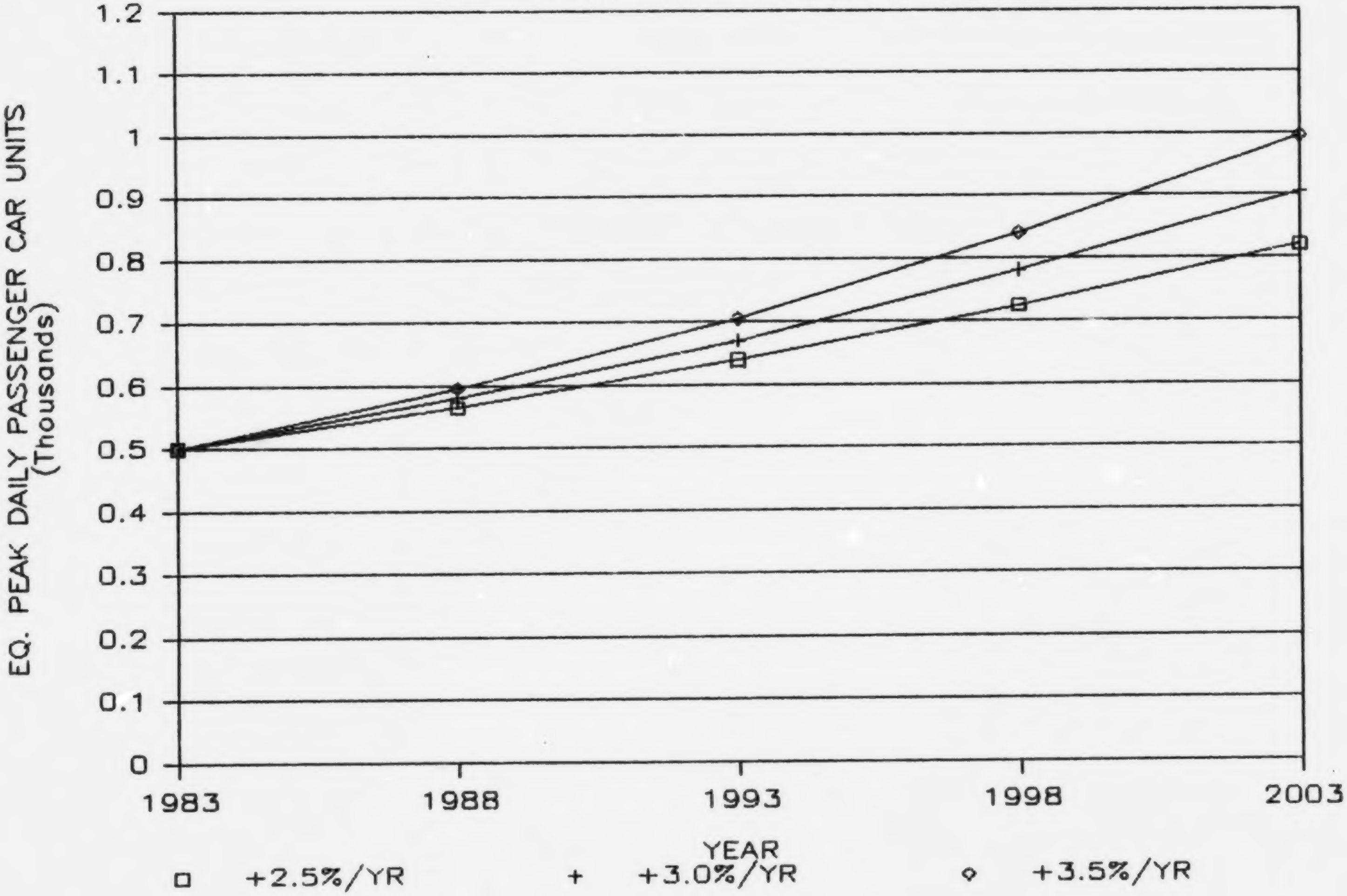
- 2.5 percent per year;
- 3.0 percent per year; and
- 3.5 percent per year.

The results of applying these three different annual growth rates to the 1983 two-way total base level of 500 passenger car units per day during the peak summer design day are illustrated in Figure 3.1. This figure indicates that the relative difference in the base daily traffic demand is greater the further one projects these forecasts into the future. However, for the ten-year time frame during which the DPA Group prepared estimates for the park traffic, the variation in potential growth rate for the base traffic has a relatively insignificant impact on the base component of traffic demand in Year Ten. More explicitly, the Year Ten estimates of base year daily passenger car equivalents is 705 for the 3.5 percent per year growth rate compared to 640 for the 2.5 percent per year growth rate. This represents a difference in the Year Ten estimates of only about ten percent. By Year 20 in the planning horizon, the base year traffic demand associated with the 3.5 percent per year compound growth rate would result in the passenger car equivalent level being about 20 percent in excess of what it would be for the 2.5 percent per year rate of growth.

It is evident that the ferry services are influenced by constraints in addition to those which might normally occur for mainland transportation facilities. By way of comparison, a preliminary review of forecasts for traffic growth in other areas of the province was undertaken. Based on this general evaluation and recognizing the inherent constraints of ferry

FIGURE 3.1

LETETE FERRY BASE TRAFFIC ESTIMATES



services, it was considered that the 3.5 percent per year growth for base traffic would be appropriate for the demand in base (non-park) traffic between Deer Island and Letete. This figure has been used for the base (ie. existing traffic) component in the future traffic demand estimates described in the following section. This value is considered appropriate because some level of ferry service improvement (which would at least in the short term remove an existing constraint on local traffic) would be required for both of park Options I and II. The above observations and the results plotted in Figure 3.1 illustrate the sensitivity of these base traffic forecasts to the equivalent annual growth rate utilized. As noted in the above paragraph, the impact of the growth rate used on future base year traffic demand by Year 10 is only about 10 percent.

As noted earlier, the impact of a marginal adjustment in the growth rate utilized does not have an extremely significant impact in the short to medium term. At the same time, the growth rate utilized provides a realistic estimate of the suppressed demand which would exist for the base component of traffic activity, should there be improvements in the ferry service.

3.2 Base Traffic Volumes on Primary Access Routes to Study Area

The primary access routes to the Study Area are Routes 1,127 and 772 in New Brunswick and Highway 189 in Maine, which connects to Route 774 on Campobello Island at the Roosevelt Bridge.

3.2.1 St. George to Letete (Route 772)

On the mainland, the major intersection for Route 772, connecting the Letete ferry to Route 1, is at St. George. It is proposed that for options involving development at Letete and Deer Island, the primary access to the potential marine park be via the eastern access to Route 772 at St. George. Based on data available from the Department of Transportation, the traffic volume along Route 772 between St. George and Letete results in an average annual daily traffic of about 2 000 - 2 500 vehicles. This results in an estimated peak design day traffic of a maximum of about 3 200 to 4 000 vehicles, with a corresponding peak design hour traffic of about 300 to 600 vehicles per hour. It should also be noted that these estimates are on the high side.

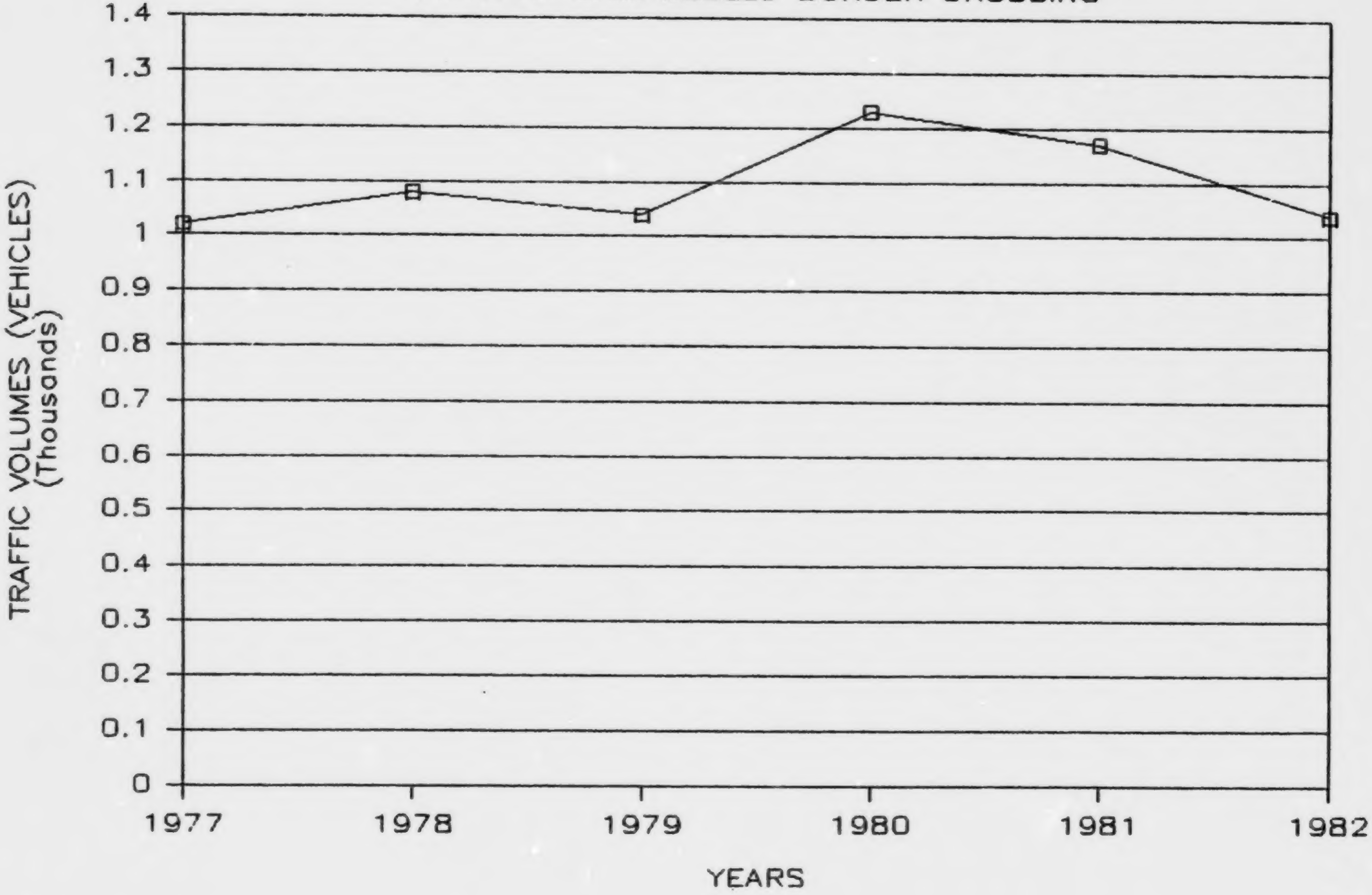
3.2.2 Campobello (Route 774)

On Campobello, information available from the Traffic Engineering Division of the Department of Transportation indicates that the average annual daily traffic adjacent to the border crossing at Campobello Island (Route 774) was about 1 040 in 1982. It is also important to note that the traffic volume at the entrance to Campobello Island has been relatively constant since 1977. In that year, the average annual daily traffic at the border crossing near the Roosevelt Bridge was 1 020 vehicles. The yearly variation in the average daily traffic volumes at this location can be summarized as follows:

Year	Average Annual Daily Traffic (Total in Both Directions)
1977	1 020
1978	1 080
1979	1 040
1980	1 230
1981	1 170
1982	1 040

The relative stability of these values is more clearly illustrated by the plot shown in Figure 3.2.

FIGURE 3.2
A.D.T. AT CAMPOBELLO BORDER CROSSING



Additional specific information on traffic vehicle counts indicate that the traffic volume on Route 774 in Campobello is typically about 1 750 vehicles per day during the peak months of July and August.

For purposes of estimating future base traffic levels (exclusive of the impact of the Marine Park) a nominal growth rate of 1.0% per year has been utilized. This results in the following estimates of future base (non-park) traffic levels:

Year	Route 774 Campobello Peak Season Design Day Traffic (Total Vehicles in Both Directions)
1985	1750
1990	1840
1995	1935
2000	2030
2005	2135

3.2.3 St. Andrews (Route 127)

For Option III, there would be an additional volume of traffic imposed on Route 127 which provides the link between St. Andrews and the main arterial highway across southern New Brunswick (Route 1). The primary access to St. Andrews would be along the western portion of Route 127 from the access point by the Tourist Information Center at the intersection of Routes 1 and 127 at Waweig.

Recent information on forecasts for growth in normal (non-park related) traffic on this route indicates that existing traffic levels are not expected to exceed more than about 50 percent of the highway capacity within the next 15 years. In fact, this observation is based on the most optimistic of three sets of traffic forecasts available for this route. Such optimistic estimates result in average daily traffic levels by Year 2000 of 5400 to 5800 vehicles.

3.3 Park Generated Traffic

The approach to evaluating capacity constraints for the transportation facilities was to identify the existing (base) traffic levels and forecast normal growth which would be anticipated for the existing situation ignoring the impact of the potential park. To these base traffic estimates, additional traffic associated with the potential park were superimposed. The critical element of future demand is that related to the potential park. Utilizing the information provided in the report by The DPA Group, the park generated traffic for both Letete (Greens Point), Deer Island, Campobello and St. Andrews were determined. This analysis included consideration of the Route 772 access to Letete, the Letete/Deer Island Ferry crossing, Route 772 on Deer Island, Route 774 on Campobello and Route 127 to St. Andrews.

The primary sources of input for this analysis were the visitation forecasts presented in The DPA Group report regarding the socio-economic impacts of the park. It must be recognized that the procedure used by The DPA Group to determine the estimates for traffic to Campobello Island incorporated an approach which assumed that the Marine Park would attract a portion of the traffic already visiting the island to see the Roosevelt Estate. Consequently, it was important to ensure that the overall incremental traffic activity associated with the Marine Park did not include double counting of elements of the potential park traffic such as that related to the Roosevelt Park. Similar considerations were used to estimate the traffic at Greens Point and St. Andrews. The DPA Group estimates of incremental park traffic generated solely from the creation of the potential marine park are summarized in Table 3.1. This table illustrates the anticipated number of additional visitors generated as a result of the Marine Park for each year of the first ten years subsequent to initiation of park development.

Table 3.1

INCREMENTAL VISITORS GENERATED AS A RESULT OF A MARINE PARK*

Peak Season** Visitor Volume (000)

Area/Option	Year 1	2	3	4	5	6	7	8	9	10
Greens Point (Option I)	-	0.8	1.8	3.7	5.8	9.3	13.0	17.2	20.7	22.8
Campobello (Option II & III)	-	1.0	2.6	3.8	5.5	7.6	9.7	12.1	13.9	15.5
St. Andrews (Option III)	-	-	-	-	-	-	-	3.6	6.4	7.9

* Source: The DPA Group.

** The peak season traffic is the total visitors estimated to occur during the peak period of May to October inclusive.

Table 3.2

PEAK PERIOD DESIGN DAY INCREMENTAL TRAFFIC GENERATED AS A RESULT OF THE MARINE PARK

	Peak Period Typical Design Day Incremental Two-Way Traffic* (Vehicles)									
	Year									
Area/Option	1	2	3	4	5	6	7	8	9	10
Greens Point (Option I)	-	7	15	31	48	77	108	143	172	190
Campobello (Option II & III)	-	8	22	32	46	62	80	100	114	128
St. Andrews (Option III)	-	-	-	-	-	-	-	30	53	66

* These estimates were derived from the DPA visitation estimates summarized in Table 3.1. The estimates are expressed in terms of passenger car equivalents based on: a). 33% of the peak season (May to October) traffic occuring in the peak month, b). the design day traffic being equal to the average daily traffic during the peak month and c). an average vehicle occupancy equal to 2.56 persons.

Table 3.2 summarizes the net impact of this additional traffic in terms of the resulting effect on vehicular traffic flow. Table 3.2 provides an indication of the incremental two-way traffic volume of passenger car units along the primary access route to each of the major geographic areas of the park affected. These estimates have been prepared on the basis of the seasonal variation factors included in The DPA Group report. The primary factors relating to conversion of the visitor estimates to equivalent traffic estimates were the fact that 33% of the peak season (May to October) traffic occured during the peak month of the season. Also, the typical design day is considered to be equal to the average of the traffic occuring during the peak month. As well, an average vehicle occupancy rate of 2.56 persons was utilized. The information in Table 3.2 for the most critical of the three locations have also been plotted in Figures 4.1 and 4.3. These figures indicate the general build-up of demand related to park visitor activity forecasts for the first ten years of operation of the facility.

The net impact of the park in terms of additional demand on the transportation system is clearly indicated because the numbers which have been summarized in these figures are essentially equal to the incremental impact in the design day vehicular traffic. The maximum potential impact occurs in conjunction with the access to the West Isles/Deer Island area.

As can be seen from Table 3.2, the incremental vehicular impact of Option III on access to St. Andrews is insignificant in terms of the effect on highway capacity. For Option II, the greatest incremental impact is on Campobello Island and Deer Island. For Option I, the major potential for impact is in the Greens Point area. This is a particularly critical factor because of the potential spin-off impact on the Deer Island - Letete Ferry service. This topic is addressed in more detail in Chapter 4.

4.0 CAPACITY EVALUATION/IMPROVEMENT REQUIREMENTS

The information presented in Figures 4.1, 4.3, 4.5 and 4.6 were utilized to determine the impact of incremental park traffic on the capacity of various critical components of the transportation system serving the park area. This traffic was superimposed on the forecasts for base traffic levels associated with the existing (non-park) activity in the Study Area. The forecasts of base traffic activity had been presented earlier in Section 3.2.

The results of this analysis are summarized in the following subsections. It should be noted that this evaluation has considered the distinction between the various Park development Options where appropriate. In some cases the impacts are similar for two or more of the three park options. Such cases are noted in the discussion relating to various elements of the transportation infrastructure.

4.1 St. George to Letete Access Route (Route 772)

This route is affected by park development Options I and II. The existing traffic on Route 772 in the peak period is estimated to be less than 4 000 vehicles per day. Since the incremental traffic for Option I illustrated in Figure 4.1 results in an estimated year 10 two-way car equivalent volume for the typical peak period design day of less than 200 vehicles, it is evident that the impact of the marine park would not be significant in terms of vehicle capacity. Even in the extreme case of assuming all traffic associated with the Greens Point component of the park (see Figure 4.2) were to be incremental traffic, the typical additional demand on the access route from St. George would be less than 350 car equivalents (two-way) in the design day during the peak season after the park had been implemented and activities stabilized. Accepting these estimates prepared by The DPA Group, the net impact on Route 772 is not a problem from a vehicle capacity perspective for park development Option I. Similarly, the traffic associated with park development Option II would not adversely affect the capacity of Route 772. In fact, the DPA estimates indicate the impact would be less for Option II than for Option I.

FIGURE 4.1 – INCREMENTAL TRAFFIC
GREENS POINT – PARK – (OPTION I)

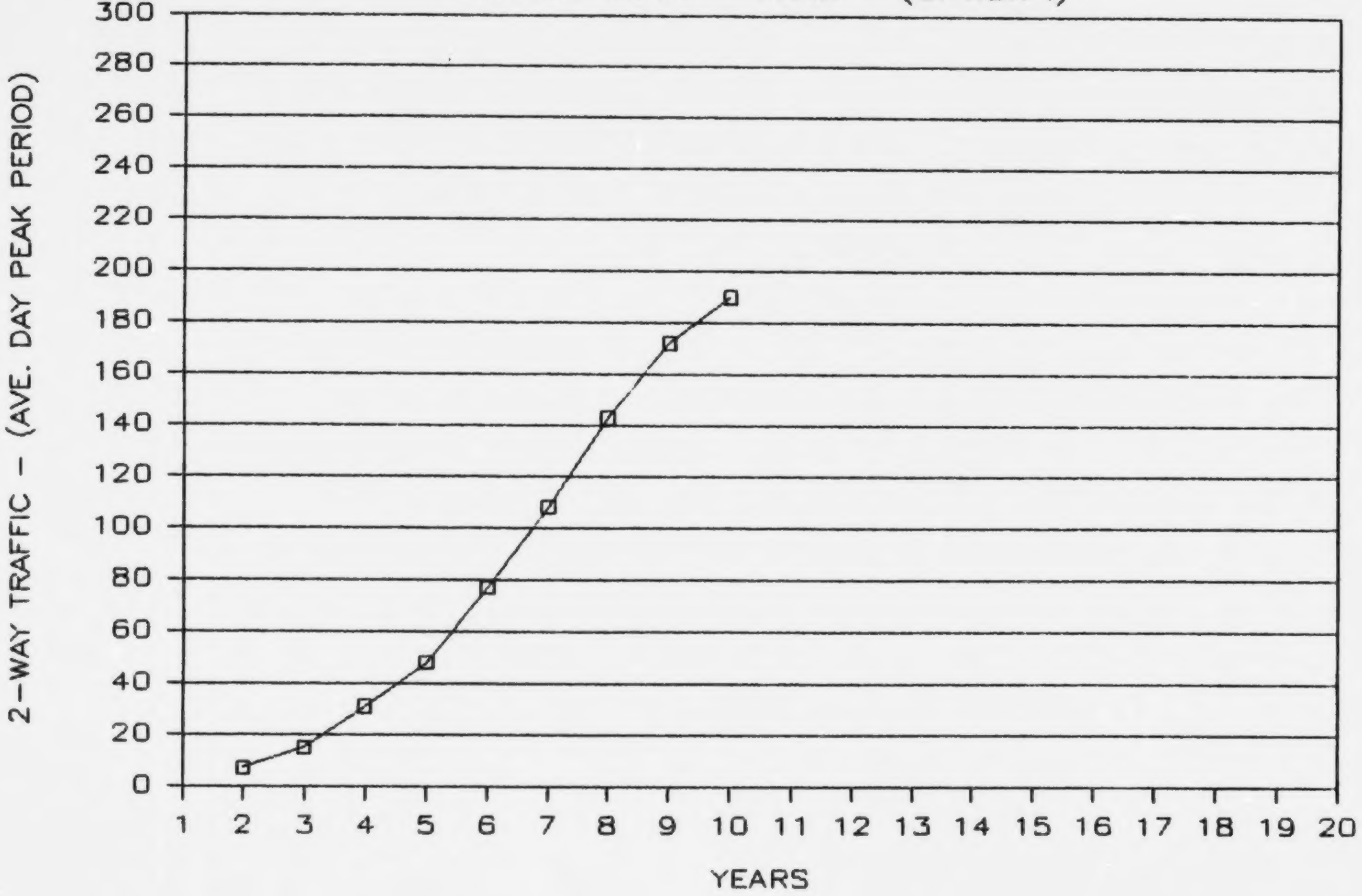
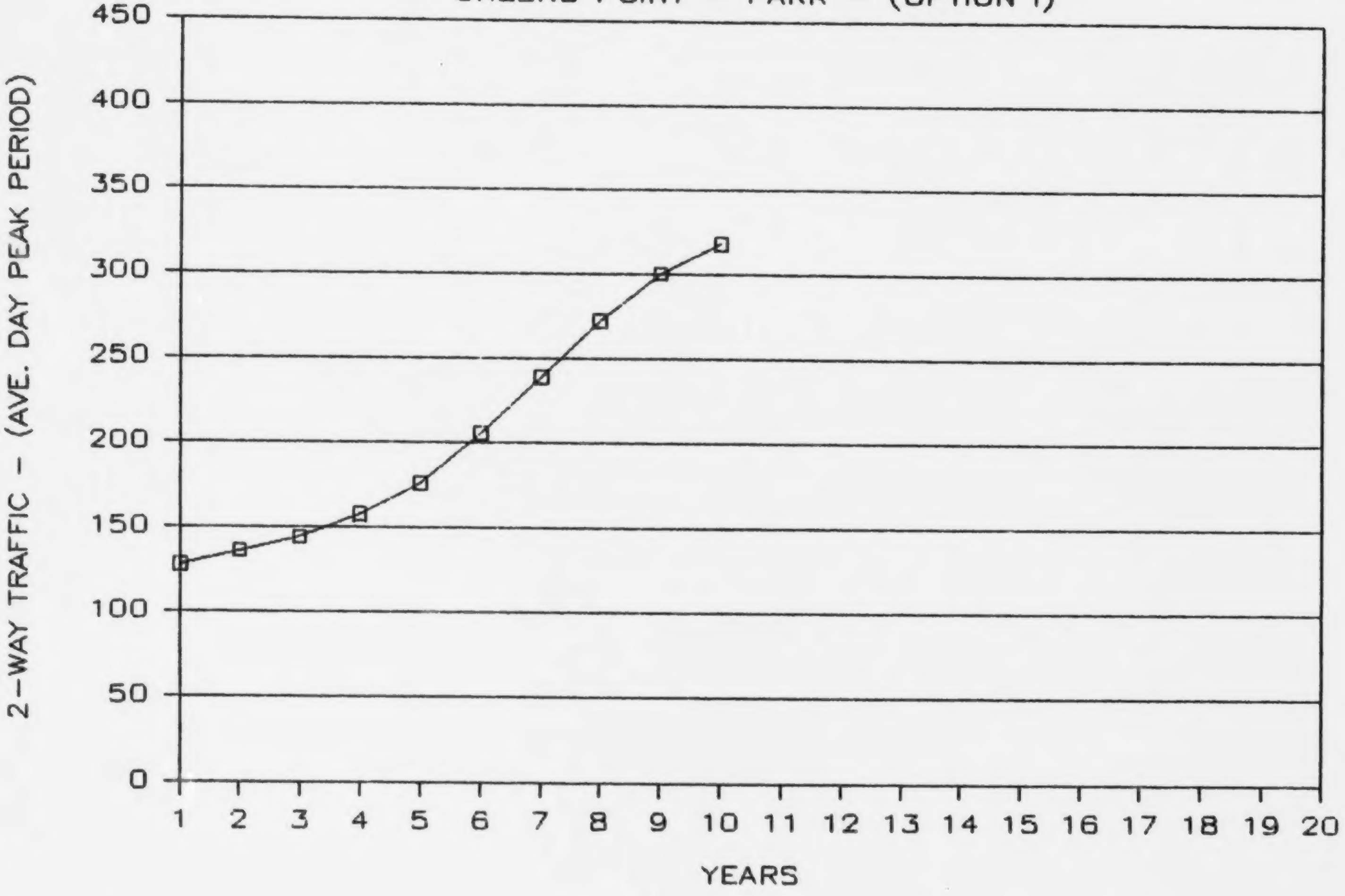


FIGURE 4.2 – TOTAL TRAFFIC TO PARK
GREENS POINT – PARK – (OPTION I)



4.2 Campobello Access (Route 774)

The information presented in Section 3.2.2 indicated that the average daily traffic on Route 774, which is the main highway on Campobello Island, would be only slightly in excess of 2 000 vehicles per day by the year 2000. Superimposing the incremental traffic illustrated in Figure 4.3 on this base demand would result in a marginal increase in the peak design day traffic of less than 130 additional vehicles. Again, this incremental traffic is relatively insignificant since it is less than 10% of the anticipated base traffic volumes at that point in time. The extreme case would be to consider the total Marine Park traffic as incremental additional traffic in excess of all other traffic to Campobello (see Figure 4.4), the extra two-way peak day traffic by year 10 would only be about 620 vehicles. Even this value could be readily accommodated on Route 774 between the Roosevelt Bridge and the Wilsons Beach area. However, the portion of the access road to Head Harbour Point (north of the intersection with the road to Head Harbour Wharf) would require upgrading. This applies to both Options II and III. The cost of this upgrading is summarized in Table 4.6.

4.3 St. Andrews Access (Route 127)

Route 127 to St. Andrews is affected only by Park development Option III. The limited volume of incremental park traffic to St. Andrews under Option III is only about one-half to one-third of the corresponding values for the Greens Point and Campobello areas for any of the three options (see Table 3.2). At the same time, the access route to St. Andrews (Route 127) is superior in quality to the routes (Routes 772 and 774) serving Greens Point and Campobello. As noted in Section 3.2.3, there is substantial excess vehicular capacity in the St. Andrews access route (Route 127). Certainly, the incremental park related traffic of only about 66 vehicles per day in the peak season in Year 10 is a relatively insignificant impact on the existing traffic levels on this access route.

FIGURE 4.3 – INCREMENTAL TRAFFIC
CAMPOBELLO – PARK – (OPTION II)

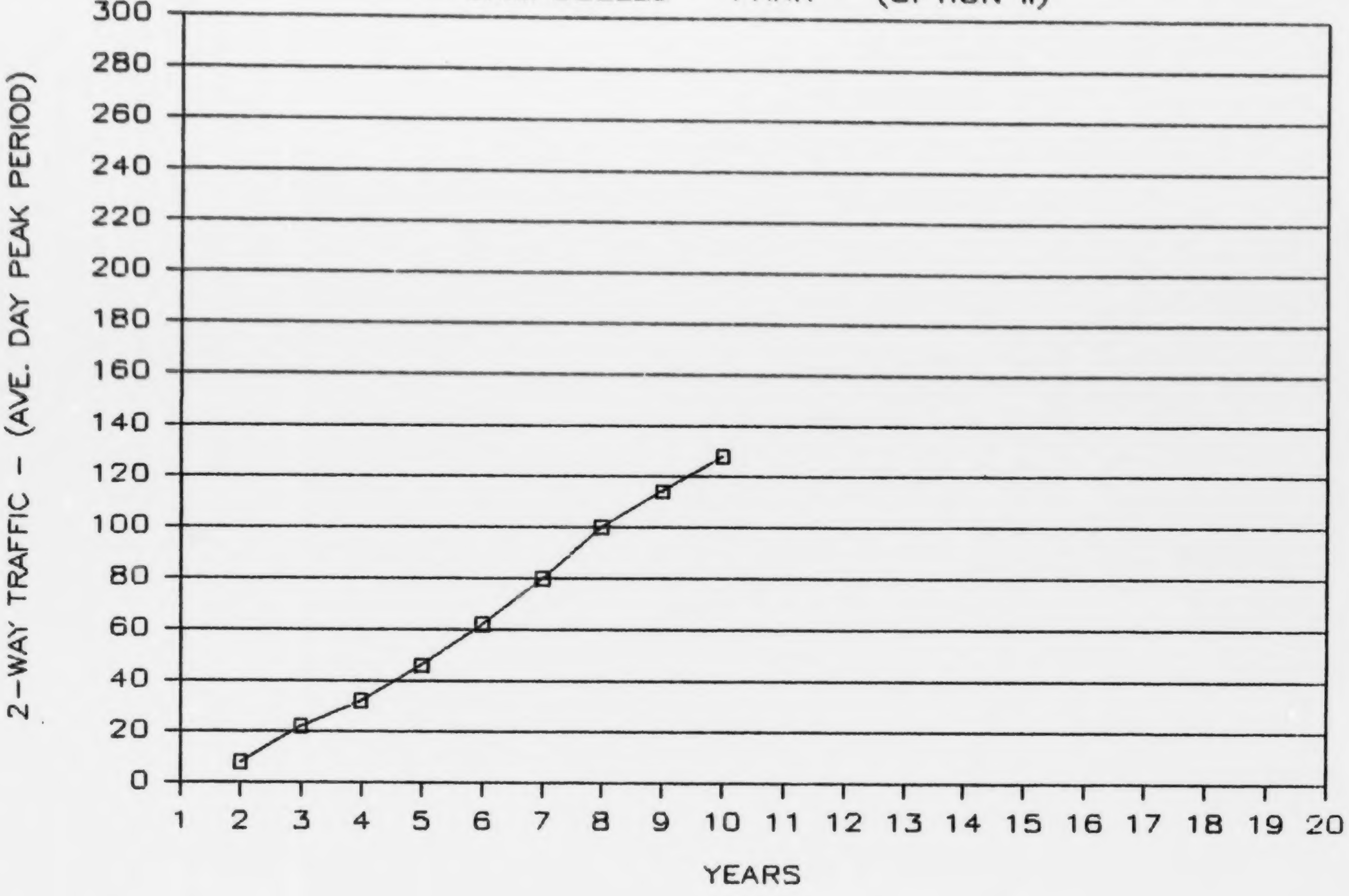
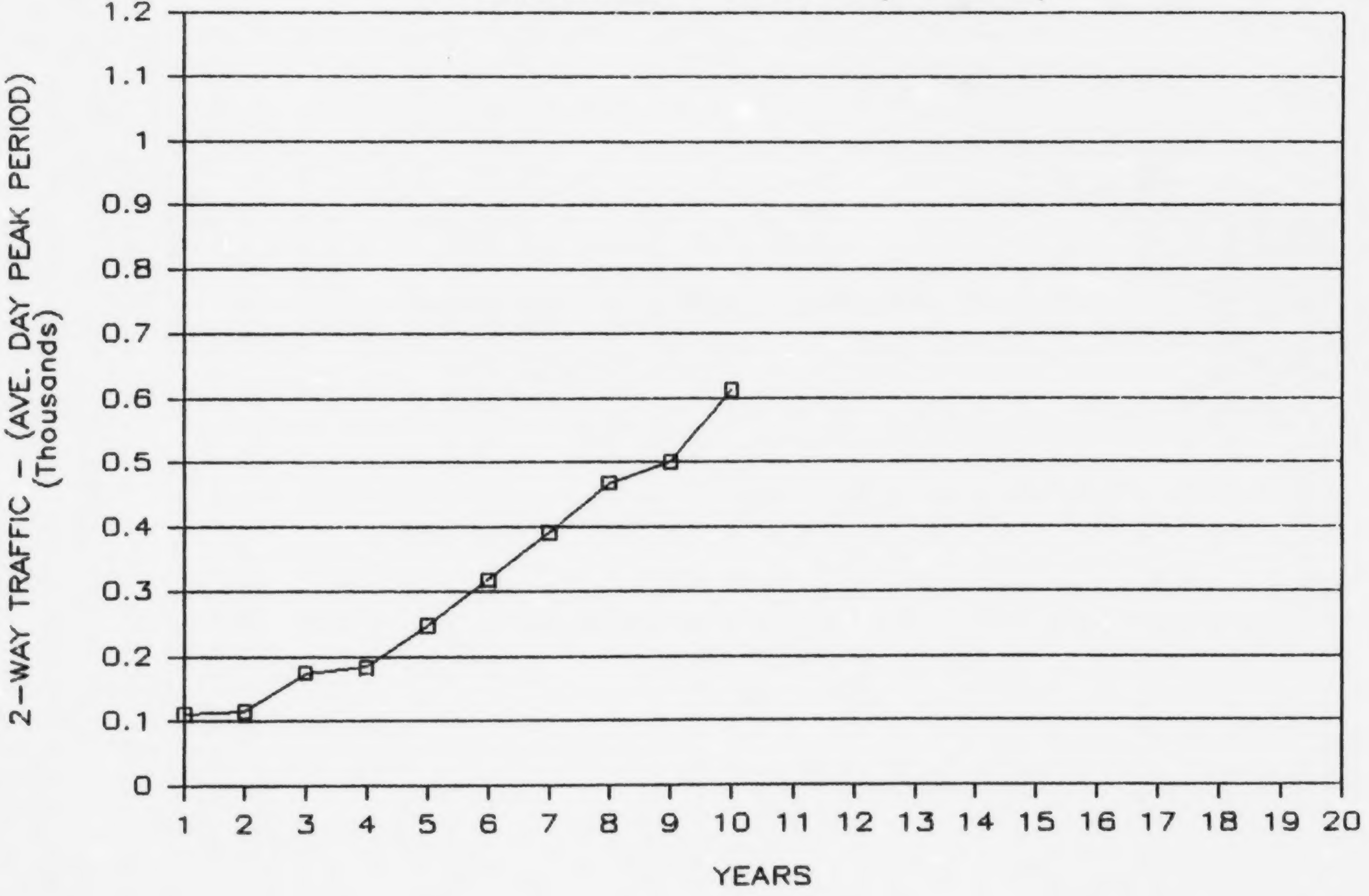


FIGURE 4.4 – TOTAL TRAFFIC TO PARK
CAMPOBELLO – PARK –(OPTION II)



4.4 Letete/Deer Island Ferry Service

4.4.1 Evaluation of Demand Levels (for Park Options I, II and III)

The primary area of potential impact regarding the incremental traffic generated as a result of the Marine Park relates to the Letete/ Deer Island ferry service. As noted in Section 2.3, the existing ferry service operates essentially at capacity during the summer period. This relatively stable activity results partially from the inherent character of the island ferry service. However, to superimpose an additional level of demand on the service would necessitate improvements in the service at a very early stage in the development of the park. Otherwise, the incremental demand imposed on the service will result in a deterioration in the quality of service to the local residents. This deterioration would result in increased delays and inconvenience during the summer season.

The critical question to be resolved regarding the impact on the ferry service is that relating to identification of the probable influence of the Park related traffic on the demand for ferry service.

The nature of development with Option III is such that the overall net impact on vehicular demand in the Letete area would be insignificant because there would be no park related developments on Deer Island or in the Letete - Greens Point area. This question is therefore relevant only for park development Options I and II.

The basic approach taken by DPA in determining visitation estimates for the Letete component of the park for Option I was to establish the portion of existing resident and non-resident visitors which would also use the marine park. To this estimate, they added additional traffic which is currently not visiting the area but would be attributed solely to the park. A similar approach was taken for the Deer Island component of park development relating to Option II. However, for this case DPA assumed the activity to Deer Island to be totally constrained by the ferry capacity. From a transportation service perspective, this is unlikely. There will be inevitable pressures on the ferry service with either of Options I or II. In the case of Option I, the additional demand would occur simply by the presence of the park visitors being at Greens Point which is immediately adjacent to the Deer Island Ferry Terminal. With Option II, there will be demand associated with the facilities directly on Deer Island. For this Option, it does not seem practical to assume that park visitors would actually be constrained by the ferry capacity. Typically, the visitors will have more time available and would probably be prepared to wait in the ferry lineup for a longer period of time than would be considered reasonable by the residents of the area.

The estimated net impact of demand exerted by the park has been superimposed on the potential growth in base (non-park) traffic illustrated in Figure 3.1. Because of the uncertainty regarding the extent to which the DPA park visitation estimates represent actual incremental impacts on the ferry service, a range of possible impacts on the ferry service demand were prepared. These values are illustrated in Table 4.1. For Park Option I (Greens Point) the levels of ferry demand for the various scenarios shown in Table 4.1, in terms of two-way car units per day in the peak season, are illustrated in Table 4.2. The resulting total demand for Case C were superimposed on the base (non-park) traffic and illustrated in Figure 4.5. Cases A and B would result in lesser total impacts. However, for all cases, improvements in the ferry capacity would be required because the service is currently running at capacity during the summer season.

For purposes of evaluating ferry service improvements, only Cases B and C are considered for Option I because of practical implications regarding potential ferry service improvements. That is, to be realistic, any improvment would have to represent a reasonable incremental improvement in the nature of ferry service. The incremental levels in demand for Case A do not represent a basis for developing a realistic option for improved ferry service.

Table 4.1

RANGES OF POSSIBLE ADDITIONAL DEMAND FOR FERRY SERVICE AS A RESULT OF INCREMENTAL PARK TRAFFIC

Park Option	Additional Demand on Ferry	
	Case	Description
I	A	25% of incremental demand to Greens Point
	B	60% of incremental demand to Greens Point
	C	100% of incremental demand to Greens Point
	D	100% of total demand to Greens Point
II	A	25% of total base year Butler Point demand
	B	60% of total base year Butler Point demand
	C	100% of total base year Butler Point demand
III		10% of Incremental Demand Potential for St. Andrews

Table 4.2

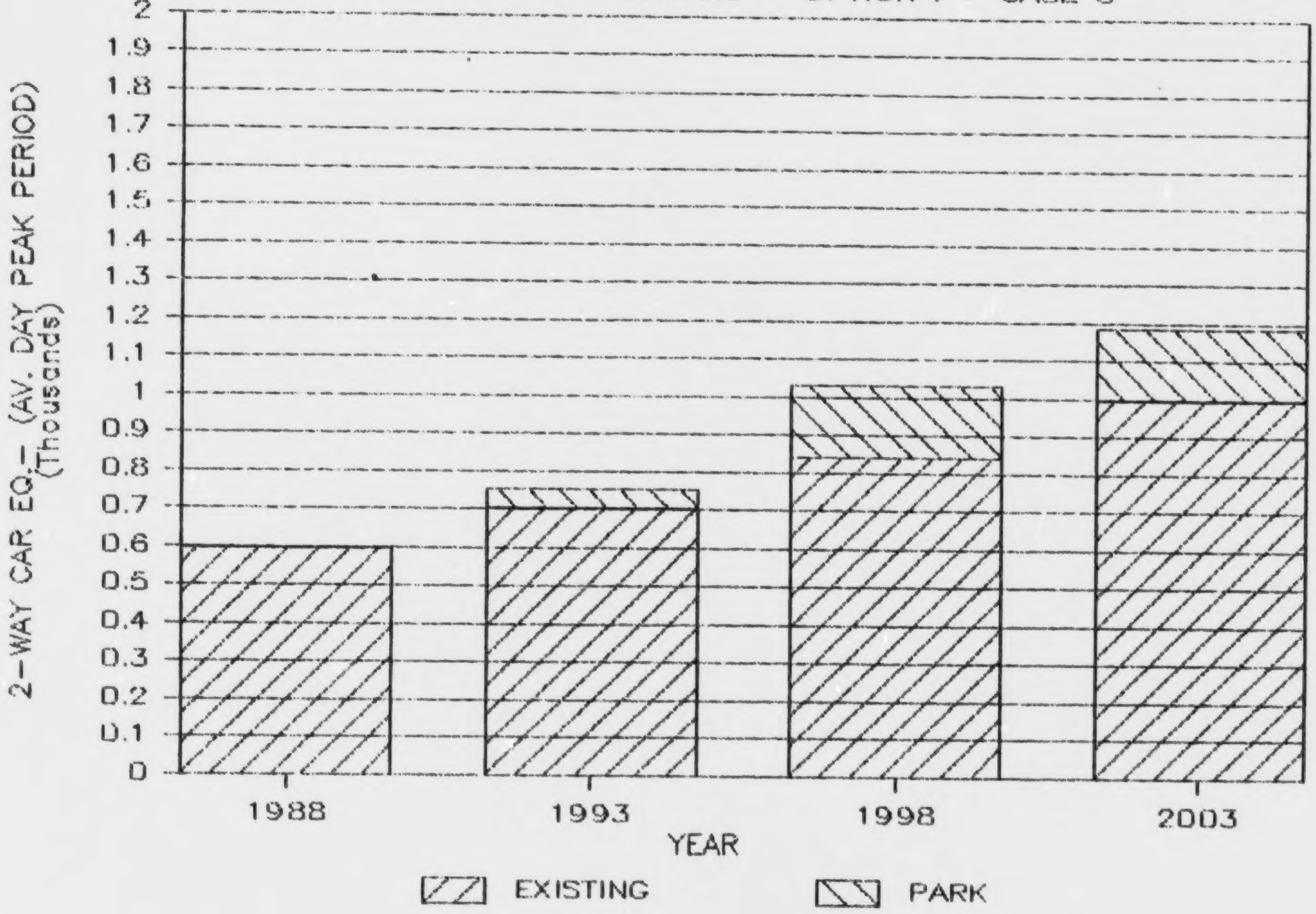
POTENTIAL TWO-WAY CAR EQUIVALENT DEMAND LEVELS
ON LETETE FERRY SERVICE FOR PARK OPTION I

	Demand (Cars Per Day)									
	Year									
Case*	1	2	3	4	5	6	7	8	9	10
A - 25% of Total	-	2	4	8	12	19	27	36	43	48
B - 60% of Total	-	4	9	19	29	46	65	86	103	114
C - 100% of Total	-	7	15	31	48	77	108	143	172	190

* See Table 4.1 for Definition of Cases. These traffic estimates are based on different possible portions of the total incremental traffic to the Greens Point area for Park Option I.

FIGURE 4.5

LETETE FERRY DEMAND – OPTION I – CASE C



This is true, especially for the early years in the park development. In practical terms, based on consideration of inevitable negative impacts regarding delays and inconvenience to existing users, it is necessary to consider some level of basic improvement in ferry service for Option I as well as for Option II.

The potential demand levels for Park Option II (which involves development at Butler Point on Deer Island) are more difficult to formulate given the nature of input data available on park visitation levels. One interpretation of demand would be to assume that all of the Option II demand estimated for Deer Island would be incremental. This would result in about 126 additional two-way vehicle trips in the base year of development (1988). Several other uncertainties exist regarding this option. For example, as noted in Table 4.1 we have generally considered the possibility of two other levels of base year demand (i.e. 25% and 60% respectively of the DPA estimates of base year visitation at the Butler Point facility). Therefore, the potential additional base year demand to Deer Island from park related traffic for Option II could be:

Case A - 32 two-way trips per day;
Case B - 76 two-way trips per day; and
Case C - 126 two-way trips per day

For this park Option (#II) however, the DPA visitation forecasts did not provide estimates of growth in visitation levels for subsequent years in the study period. For this Option, some level of improvement would obviously be required in the ferry service since it is already running at about full practical capacity in the summer season. Any additional pressure on the ferry due to park traffic would obviously necessitate some level of improvment in the existing ferry service. Such a relief in the existing capacity constraint would also imply an opportunity for increasing demand in park traffic for years subsequent to its initial implementation.

It is our opinion that this potential for growth in park demand during subsequent years counterbalances the uncertainty in the actual level of true additional base year demand which would result with the park facilities on Deer Island as envisioned for Option II. Therefore, we consider a realistic estimate of the actual demand for additional ferry service would be to assume that Case C (see Table 4.1, i.e. 126 two-way trips per day in the peak) would apply throughout the planning horizon for Option II.

The resulting demand for ferry service with this approach is illustrated in Figure 4.6. This figure illustrates the share of total demand which is associated with park traffic as compared to the growth in non-park traffic which is likely to occur once the existing ferry service capacity constraint is removed.

The two potential levels of ferry service demand for Park Options I and II shown in Figures 4.5 and 4.6 are also illustrated in Figure 4.7. It is evident from this figure that the total ferry demand for both Options I and II are similar. Option I would result in slighty less demand in the early years with a slightly greater level of demand in the latter years of the planning horizon. However, for purposes of planning realistic levels of improvements to the ferry service, the two basic estimates shown in Figure 4.7, are for all practical purposes, essentially the same. The only difference in the resulting improvements necessary to accommodate the demand for Options I and II would be adjustments in the timing of specific improvement requirements.

It should also be noted that the resulting demand associated with Case B for Option I would not be significantly different than that for Case C which is shown in Figures 4.5 and 4.7. For example, the total demand in Year 2003 would be 1109 trips compared to the total of 1185 shown in Figures 4.5 and 4.7. This difference is only about 5% which is not great enough to have any significant impact on the general level of ferry service facilities required. Certainly, recognizing the accuracy of the input data on visitation levels, this is not a significant difference.

FIGURE 4.6

LETETE FERRY DEMAND -- OPTION II CASE C

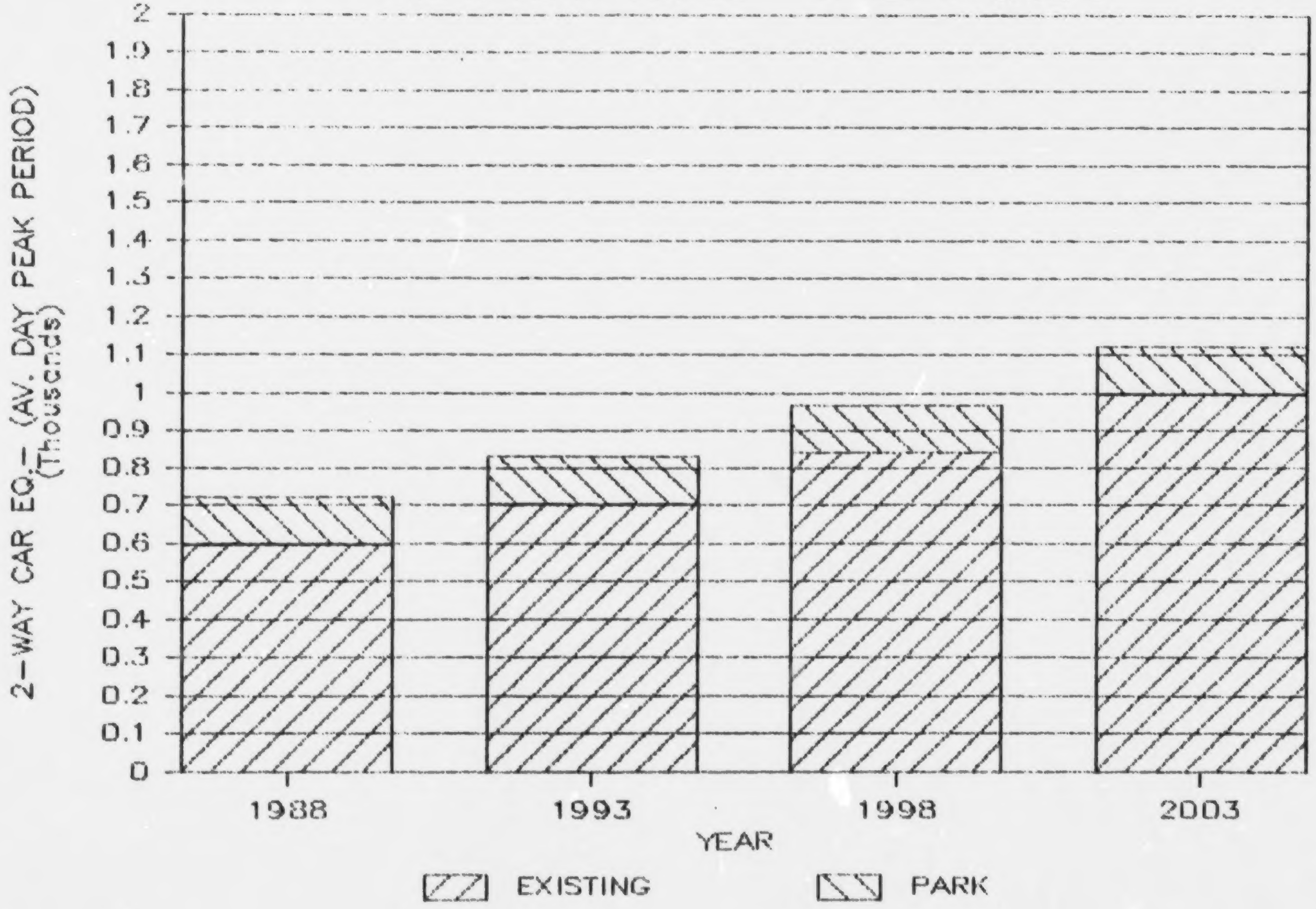
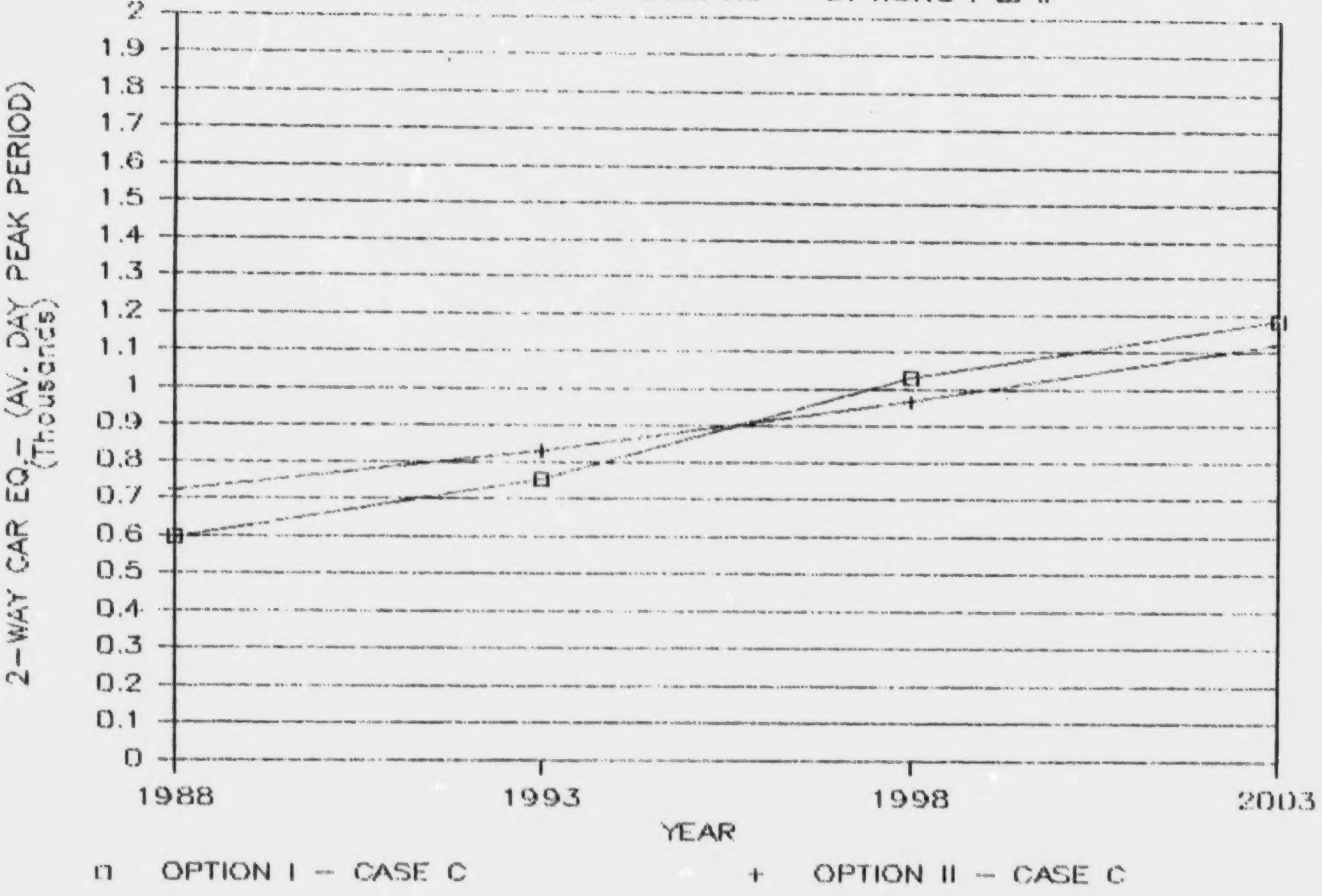


FIGURE 4.7

LETETE FERRY DEMAND -- OPTIONS I & II



Aside from the above discussion regarding the potential estimates illustrated in Figure 4.7, it must be acknowledged that there is substantial uncertainty as to the visitation levels actually likely to occur for Options I and II. It is also possible to assume that regardless of the approach utilized by DPA to establish the visitation forecasts, it could be realistic to assume that all park related traffic would be incremental to the existing levels of ferry activity. This could be argued as resulting in double counting. However, it is also possible to contend that it is not realistic to assume (as DPA did) that such a large portion of the Marine Park traffic would simply be a diversion of existing non-resident traffic to Deer Island. With such an approach, it would seem reasonable to simply accept the DPA estimates of total traffic and treat this as a reasonable level of park visitation - all of which could be considered as incremental to the existing ferry service.

With such an approach, the total park visitation levels for Greens Point under Option I could be treated as incremental park related demand. The total demand associated with this option (#D - Table 4.1) is illustrated in Figure 4.8. This figure illustrates the relative breakdown of demand associated with the existing (non-park) as well as the park related traffic.

Figure 4.9 shows the resulting total demand estimate for Case D - Option I along with the previously illustrated values for Case C - Option I and Case C - Option II.

Even though Case D - Option I represents a potentially attainable level of demand for ferry service, it is acknowledged that it could inherently imply a level of double counting. To counteract this potential double counting, it seems reasonable to consider only some portion of the demand for Option I - Case D as being an appropriate level for the additional demand for ferry service with Option I.

To be consistent with the other scenario levels agreed to with the Transportation Steering Committee, a possible ratio of 60 percent of the

FIGURE 4.8

LETETE FERRY DEMAND – OPTION I – CASE D

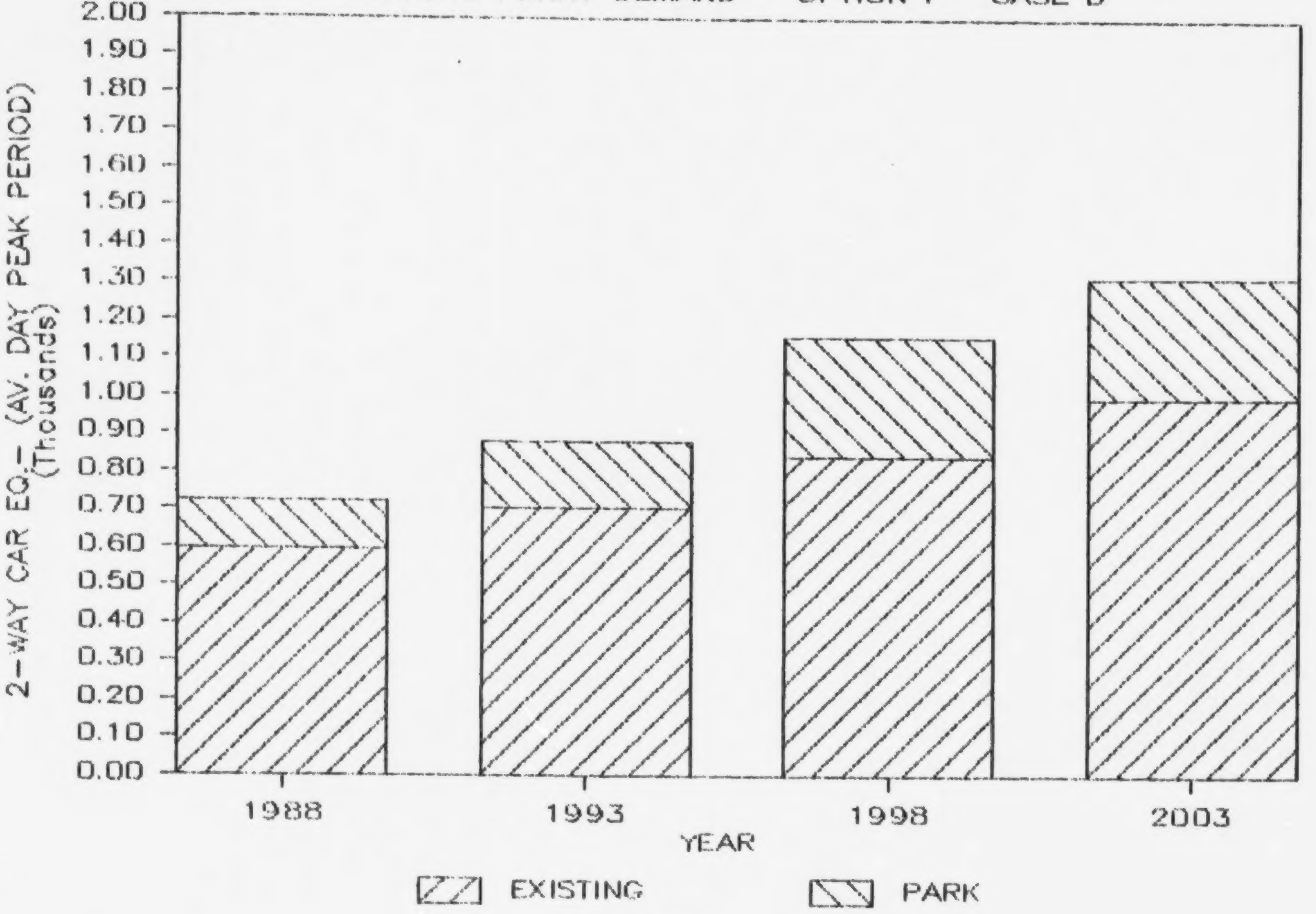
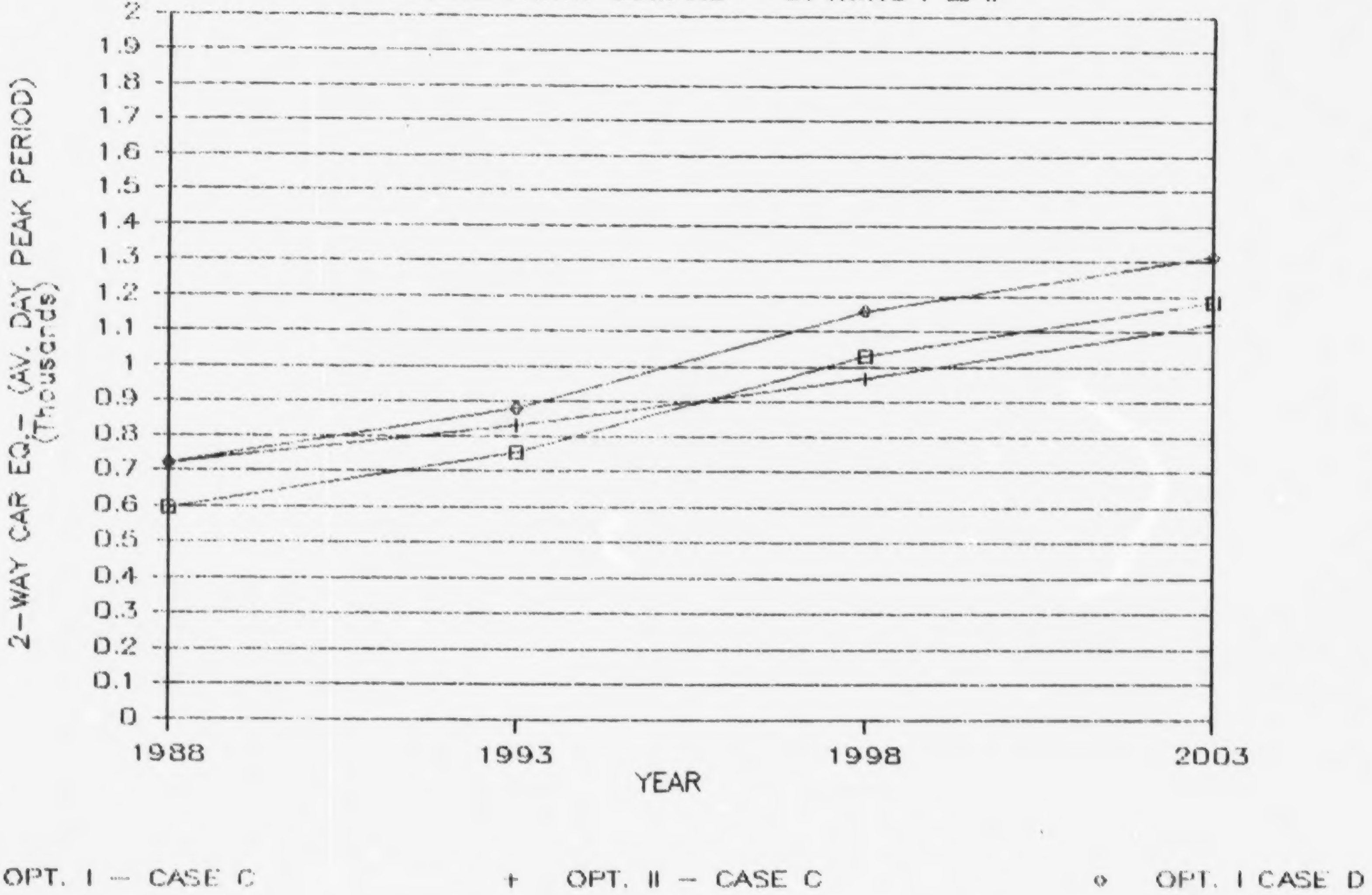


FIGURE 4.9

UTETE FERRY DEMAND -- OPTIONS I & II



total park traffic to Greens Point for Option I - Case D was calculated. This adjustment resulted in total demand in the more critical latter years of the planning horizon being essentially equal to the values illustrated in Figure 4.7 for Option I - Case C.

Given the fact that:

a). the total demand estimates in Figure 4.7 are similar for Option I (Case C) and Option II (Case C); and

b). the demand associated with 60 percent of Option I - Case D is essentially equal to that for Option I - Case C,

subsequent analysis of proposed ferry service improvements were based on the demand levels indicated in Figure 4.5 for Option I - Case C. The resulting analysis is considered to apply equally to Options I and II (with the exception that minor adjustments would be necessary in the timing of improvement elements).

It should also be noted that no specific consideration was given to ferry service improvements for Option III. That option would have no facilities in the Letete, Greens Point or Deer Island areas. The major difference in this Option is the fact that no park facilities are located in the general area served by the Letete ferry. Therefore, the implications are implicitly secondary in nature. Consequently, Option III is totally different in terms of basic impact on the ferry service. For this Option it is reasonable to assume that any spin-off demand would be nominal in nature. As is evident from examining Table 3.1, the levels of incremental demand to St. Andrews would be low. Therefore, even assuming a nominal 10% of the St. Andrews demand (which is not expected until year eight) might eventually use the ferry, this would result in only about five to six additional vehicles a day on the ferry in the peak season (see Table 3.2). Consequently, Option III is not considered to have any significant impact on the demand for ferry service to Deer Island and no specific ferry improvements are identified for Option III.

4.4.2 Proposed Improvements (for Park Options I and II)

Having identified the potential levels of traffic demand for Options I and II on the ferry service, the next step involved determining the impact of this demand on the ferry service requirements. Several options were considered for improvements to the ferry service. The first possibility was that of simply allowing the service to stay the same which would involve increased delays and inconvenience for all users due to the necessity of waiting for subsequent crossings after the time of vehicle arrival at the ferry landing. This was not considered to be a realistic option since the ferry is already operating at practical capacity during the summer months.

The second improvement option would be to replace the D.L. MacLAREN with a ferry of characteristics equivalent to the JOHN E. RIGBY. The impact of this approach was evaluated based on an assumed operating schedule similar to that currently in service. The results of this analysis indicated that such a system could accommodate the capacity for only about seven years without exceeding the desirable average load factor during the peak period of 85 percent. Since this is a relatively short term of functional service, it was not considered to be a realistic option (With Option II, this approach could be effective for an even shorter period).

The next alternative considered was that of replacing the D.L. MacLAREN with a vessel of characteristics which would be compatible with the existing ferry terminals but would provide a vehicle capacity in excess of that available with the JOHN E. RIGBY. Discussions with a marine architect (Maritime Marine Consultants Ltd.) indicated that a ferry vessel with the capacity of 24 passenger cars could be accommodated at the existing terminals without difficulty. The characteristics of such a vessel are summarized in Table 4.3.

For Options I and II, it was assumed that a new vessel with a capacity of 24-passenger car units would enter service by 1988 (this coincides with

Table 4.3

CHARACTERISTICS OF A NEW
24-CAR FERRY VESSEL

Item	24-Car Ferry
Length of Hull (m)	45.7
Breadth of Main Deck (m)	10.0
Depth (m)	2.4
Capacity (cars)	24
Operating Speed (knots)	10
Hull Type	Steel
Type of Engine	2 @ 435 HP

the assumed Year 1 of the Marine Park). This would provide a combined daily capacity for the new vessel in conjunction with the JOHN E. RIGBY of nearly 1 100 passenger car units per day*. Comparisons of this level of capacity with the demand estimates illustrated in Figure 4.5 indicate that this arrangement would work until about Year 2000 based on 1988 being Year 1 of Park implementation.

On this basis, it was estimated that by Year 2000 a second 24-car capacity vessel would be required. This vessel would be used to replace the JOHN E. RIGBY. Based on a 15-hour schedule during the peak season, this second service improvement would result in a system with a capacity in excess of 1 200 passenger car units per day assuming a peak period average load factor of 85 percent. This combination of vessels would provide capacity sufficient to handle the anticipated demand for in excess of 15 years subsequent to implementation of the service (1988). That is, the two 24-passenger car equivalent capacity vessels would handle the traffic for the 20-year planning period implicit in this study.

Based on the infrastructure requirements associated with the ferry service noted above, the following paragraph summarizes the implications regarding general infrastructure and operating costs. The primary element of cost relates to the necessity of providing additional, larger capacity ferry vessels.

Table 4.3 summarizes the key physical characteristics of the 24-car capacity ferry proposed for improvements to the Letete/Deer Island ferry service for Options I and II. The basic configuration of this vessel has been developed on the assumption of utilizing the existing terminal facilities at both Letete and Butler Point on Deer Island. This minimizes the necessity to construct new terminal facilities and approach/loading ramps. As with the existing service, the vessels would require two crews to operate the proposed double shift schedule. The crews would involve one captain, one engineer and two deck hands.

---

* This estimate is based on an 85 percent load factor for a 15-hour daily schedule (ie. 30 trips per day).

4.4.3 Capital Cost of Infrastructure (Options I and II)

The estimated cost in 1984 dollars for a new 24-car ferry would be about 4.1 million dollars.

Table 4.4 summarizes the magnitude and scheduling of expenditures associated with the general improvement program anticipated for the Letete/Deer Island Ferry Service in order to accommodate the additional traffic which would be generated as a result of the Marine Park Options I and II. The primary items of expenditure are those related to acquisition of the 24-car ferries. These acquisitions are estimated to occur in 1988 and in Year 2000. The current (1984) value of the new vessels to be aquired in those years is 4.1 million dollars. Also, Table 4.4 indicates the approximate cost of upgrading the approaches at the ferry landings to accommodate a double - lane marshalling compound at both the Letete and Deer Island terminals. The improvements anticipated at both terminals are limited to upgrading the approach roadway by providing ditching and expansion of the approach roadway widths in order to provide additional storage area for a two-lane holding compound along the terminal approach roadways at Letete and Butler Point.

It should also be noted that operationally, during the peak season there would be the requirement for marshalling compound attendants to supervise assembling vehicles in the compounds and assist in directing traffic during the loading and unloading operation. This is required because of the difficulty in providing appropriate signing to perform this function in light of the relatively confusing requirement to store two lanes of traffic at the ferry terminals. More importantly, the confusion would arise during the loading process when, on occasion, vehicles would be required from both storage lanes. In cases where it is uncertain as to which lane has priority, there is a high probability of confusion if an attendant is not provided to supervise the loading operation. Provision for this additional element of cost, which would involve a total of four people (i.e. - 2 shifts with one attendant at each terminal for each shift), is included in the incremental operating costs summarized in Section 4.4.4.

Table 4.4

COST SUMMARY FOR FERRY IMPROVEMENTS REQUIRED TO HANDLE INCREMENTAL TRAFFIC GENERATED BY A MARINE PARK (OPTIONS I & II)

Item	Year Anticipated	Cost in 1984 Dollars (000's)
24-Car Ferry	1988	$4 100
Terminal Marshalling Areas*		
Letete	1988	$50
Deer Island	1988	$50
24-Car Ferry	2000	$4 100
	Total	$8 300

---

* It should be noted that this service would generate 4 new seasonal jobs for the period June to September inclusive.

As indicated in Table 4.4, the total value of expenditures required for the ferry acquisition and terminal marshalling area improvements is about 8.3 million dollars (1984).

4.4.4 Operations and Maintenance (Options I and II)

The other critical factors associated with the ferry service are the effects on operations and maintenance. Recent information provided by The Department of Transportation regarding the existing ferry service indicates that the total operating and maintenance costs for the two existing vessels was about 1.5 million dollars during the fiscal year 1983/84. The approximate split in these costs between the two vessels was as follows:

1). Operating and maintenance costs for the JOHN E. RIGBY equals 840 000 dollars.

2). Operating and maintenance costs for the D.L. MacLAREN equals 660 000 dollars.

These figures include an approximate averaging for the major overhauls which occur every four to five years according to regulations imposed by the Coast Guard. Although a major overhaul was included for both vessels during the 1983/84 year, the cost of these overhauls were prorated over the average cycle for such major overhaul operations.

Table 4.5 provides a summary of the operating and maintenance costs for the proposed ferry service on the Letete/Deer Island crossing throughout the 20-year planning period of this study. As noted, the total operating and maintenance costs for the existing service involving the JOHN E. RIGBY and the D.L. MacLAREN is about 1.5 million dollars per year. The first phase of the enhanced ferry service program would involve replacing the D.L. MacLAREN in 1988 with a new 24-car capacity vessel. At that time,

Table 4.5

ESTIMATED ANNUAL OPERATING AND MAINTENANCE COSTS* FOR THE LETETE/DEER ISLAND FERRY SERVICE (OPTIONS I AND II)

		Operating and Maintenance Costs* (000's)	
		Total	Incremental**
Existing Service (Until 1988)			
John E. Rigby		$840	
D.L. MacLaren		660	
	Subtotal	$1 500	-
(1988 to 2000) Phase I of Improved Service			
John E. Rigby		$840	
New 24-Car Vessel		900	
	Subtotal	$1 740	$240
(After 2000) Phase II of Improved Service			
Two 24-Car Vessels		$900 900	
	Subtotal	$1 800	$300

---

* Based on 1984 Dollars. Note also, that minor adjustments in the scheduling of this implementation date for the second 24-car ferry vessel would be required for Option II compared to the above timing which is for Option I. These adjustments are not sufficient to alter the basic conclusions of this general feasibility analysis of public transportation requirements.

** These incremental costs are relative to the values for the existing ferry operations.

Note: These figures exclude the additional cost of $24 000 per year to cover the wages for marshalling yard attendants.

the combined operating and maintenance costs for the new 24-car vessel and the JOHN E. RIGBY would be about 1.74 million dollars per year (in 1984 dollars). This value is about $240 000 per year more expensive than the current average level of maintenance for the existing vessels.

The second phase of the improvements in the ferry service is anticipated at about Year 2000 when it is anticipated that the demand on the crossing would exceed the combined capacity of the 24-car vessel and the JOHN E. RIGBY. At that time, it is proposed that the JOHN E. RIGBY be taken out of service and a second 24-car capacity vessel be put into service. The estimated annual operating and maintenance costs for the service based on two identical 24-car capacity vessels would be about 1.8 million (1984) dollars. This would result in annual maintenance costs about 300 000 in excess of the current levels.

The general question of operational efficiency of the Letete ferry terminal was also evaluated. This included specific consideration of the loading and unloading activities and the space available to accommodate appropriate marshalling of vehicles. A preliminary review of the operational characteristics for the estimated future demand indicated that the demand could be accommodated by generating an additional holding lane along the existing approach highways. This has some inherent operational difficulties, however, it provides for a relatively inexpensive solution to providing the additional marshalling facilities required. In addition to the cost of initial improvements along the approach roadway to accommodate a dual lane holding/marshalling compound during the peak season, there would be ongoing operational costs associated with provision of marshalling attendants. One attendant would be required at both terminals to assist in traffic control during the vessel loading and unloading operations as well as assembling vehicles appropriately between vessel departures.

As an alternative to incurring additional ongoing staff costs associated with the attendant operation at the existing Letete terminal, a preliminary review of the possibilities of relocating the terminal to Kellys Cove on Greens Point was evaluated. However, even ignoring the necessity to construct a new ferry terminal structure and landing ramps, it would be necessary to upgrade the entire approach roadway between the potential new terminal at Kellys Cove and the intersection with Route 772 at the right angle turn just prior to the existing ferry terminal approach. The geometric characteristics and existing condition of this access road to Greens Point are very poor and would require upgrading of over half its length (0.8 km) and totally new construction of the remaining 0.6 km. The new construction would be required at the Greens Point end of this access road in order to provide an acceptable horizontal alignment. More importantly, realignment of the Greens Point end would be required in order to reduce the vertical alignment such that the grades would be within acceptable limits. The approximate cost of the upgrading associated with the access road and provision of an additional paved holding/marshalling compound at Greens Point would be about 450 000 dollars. It must be recognized that this cost is in addition to the cost of constructing a totally new ferry terminal if such an approach were used.

Compared to the option of providing associated marshalling coupound attendants at the existing terminal location in Letete, it is evident that the most cost-effective approach would be to continue to utilize the existing terminal facility. Assuming the necessity for providing an attendant at the Letete terminal for four months during the peak season (May to September inclusive), the estimated total present value over a 20-year planning horizon for the wage cost associated with this service is about 102 000 dollars. This is based on an assumed requirement for two attendants, one to cover each of the two shifts for the four-month period with an average cost of 6 000 dollars per attendant. Even after adding this operational cost to the estimated cost of 50 000 dollars to expand the existing approach roadway at the terminal to accommodate the necessary marshalling area, it is evident that utilizing the existing facility and providing an expanded roadway to accommodate marshalling activities is far more cost-effective than developing a new terminal at Greens Point. This observation ignores the fact that additional annual maintenance costs would also be required for the access road to Greens Point since it is about three times as long as the current terminal approach roadway.

Another factor associated with the potential utilization of a new ferry terminal in Kellys Cove (Greens Point) is that, although it would not effect the crossing distance for the ferry service between the mainland and Deer Island, it would probably be in a more exposed location relative to wind and waves. The Kellys Cove location would probably be equally susceptible as the existing Matthews Cove facility for waves approaching from seaward provided that a wave protection structure is constructed in conjunction with the terminal facility. However, for the northwest winds and associated waves coming out the Letete Passage from the Passamaquoddy Bay, the Kellys Cove location would be more exposed than the existing facility in Matthews Cove. Given the extent of exposure to a terminal at Greens Point, there would be the necessity to duplicate the entire terminal structure and associated wave protection structures. Consequently, there appears to be no advantage in considering a location other than the existing Matthews Cove terminal facility. This observation is enhanced by the fact that the existing facility is capable of accommodating the type of vessels which are necessary to meet anticipated future traffic demand.

4.5 Deer Island Highways (Route 772)

The maximum potential incremental park traffic on the main highway on Deer Island (Route 772) would result with Option II. The impact on the Deer Island highway would be comparable to that associated with the access route between St. George and Letete. The information summarized in Section 3.3 indicated that the maximum typical design day traffic generation associated with the park activities with the Greens Point Option (I) would represent a possible incremental two-way traffic volume of nearly 200 vehicles per day by the time the park demand stabilizes (Year 10). Given the existing relatively low volumes of traffic on the main route (772) on Deer Island, this maximum potential incremental park demand would not create capacity related problems.

It should be recognized however, that the highway on Deer Island is of a low standard. There are many sharp curves and abrupt grade changes with several locations where the sight distance is restrictive. As well, there are physical restrictions and infringements adjacent to the travelled surface. In some cases, these result from narrowed shoulders and/or placement of retaining structures and buildings in close proximity to the travelled way. Given the conditions of the highway on Deer Island, it would be undesirable to substantially increase traffic volumes due to the potential impact on the safety of the travelling public. As well, there would be safety implications for pedestrians who must use the road as a walkway since sidewalks are generally not provided. However, in light of the limited volume of additional traffic resulting from the DPA park visitation estimates, neither the traffic volume nor the potential implications on safety would appear to justify consideration of major expenditures associated with reallignment and relocation of highways. Such modifications would cause substantial disruption and dislocation of existing facilities and services (including residential impacts). The negative impact of such operations would probably outweigh any potential advantages which might be generated. Certainly, in light of the extremely small proportionate increase in traffic anticipated due to the park activity, there is no justification for major improvements to the highway system on Deer Island from a traffic capacity viewpoint.

The above comments regarding the impact of park traffic on Route 772 on Deer Island, apply to both Park Options I and II.

4.6 Summary of Transportation Infrastructure Requirements

This section summarizes the infrastructure requirements for the three park development Options. Table 4.6 provides a breakdown of the capital costs which are expected to be incurred by the Department of Transportation for each of the three park development options.

Most of the cost items in Table 4.6 have been discussed in previous sections of this Chapter. However, it should be noted that the requirements for upgrading the access roads to Greens Point and Head Harbour Point are also included in Table 4.6.

Table 4.6

SUMMARY OF CAPITAL COSTS ASSOCIATED WITH TRANSPORTATION INFRASTRUCTURE/SERVICES PROVIDED BY THE NEW BRUNSWICK DEPARTMENT OF TRANSPORTATION

(Costs - $Millions)

Park	Item			
Development Option	Ferry	Access Roads	Terminal Marshalling Areas	Total
I	1988 = $4.1 2000 = 4.1	To Greens Pt. = 0.400	1988 = 0.100	$8.70
II	1988 = 4.1 2000 = 4.1	To Greens Pt. = 0.400 To Head Harbour Point = 0.150*	1988 = 0.100	8.850
III	-	To Head Harbour Point = 0.150*	-	0.150

Note: Addition operational and maintenance costs are summarized in Table 4.5. All costs are in 1984 dollars.

*This assumes that the New Brunswick Department of Transportation is responsible for the Lighthouse access road to Head Harbour Point.

5.0 OBSERVATIONS AND CONCLUSIONS

This chapter provides a summary of the major observations and conclusions which have evolved as a result of the evaluation carried out in this study. The observations are presented in point form and are grouped according to the chapter of the report from which they were extracted. They are also generally presented in the sequence in which they are discussed in the respective chapters. Following the list of summary observations, a separate brief list of primary conclusions is presented.

5.1 Observations

The primary observations are as follows:

Chapter 1

1). The conduct of this study was carried out in basically three different phases. Phase I was conducted prior to having the benefit of specific information relating to the nature of park development options and the visitation levels associated with these options. The second major phase of this project was completed after receiving specific information regarding two of the park development options and the anticipated visitation levels associated with the same. The last phase of the project was completed after presentation of a draft report on the first two phases of the work. The third phase also included consideration of transportation impacts for park development Option III.

2). The work carried out during Phase I of this study involved independant attempts to identify the potential traffic levels associated with various geographical components of the Study Area. Phase I work was based on the assumption that major increases in traffic might occur. This phase of the work was also based on the assumption that there would be a requirement for direct vehicular access to McMaster Island. Major efforts were expended on evaluating the technical feasibility and preliminary costs associated with an assumed potential requirement for substantial increases in traffic volumes moving between Letete and Deer Island. These activities included a variety of options for connecting the islands between Deer Island and the mainland with a series of ferry operations, bridges, causeways and access roads. The results of this work have been documented for potential future reference in Appendix A of this report.

3). The second phase of this project was completed after a period of postponement while information was developed by others regarding the nature of park development options and their associated visitation estimates. The second phase of the project involved specific evaluation of the traffic which would be associated with the various critical elements of the transportation network accessing and within the the various geographical areas of park Options I and II. This was supplemented by specific consideration of the transportation service and infrastructure improvements necessary to accommodate the anticipated total demand on such facilities.

4). The primary details of the final three park development options eventually identified by the Client group for evaluation and the associated general estimates of visitation levels for each option are presented in Section 1.3 of this report.

Chapter 2

5). The primary Canadian access route to the potential marine park area for Options I and II is Route 772 between St. George and Letete. For Option II, access is available to the Campobello Island portion of the Study Area by means of Route 774 which connects with the Roosevelt International Bridge at Lubec, Maine. The other major island in the park area is Deer Island which is accessed by the ferry service between Letete and Butler Point. During the peak two-month summer period, supplementary private ferry services are operated from the southwestern end of Deer Island (Deer Island Point) to Welshpool on Campobello Island and Eastport. For Park Option III, which envisions St. Andrews as the primary mainland center, access is provided from Route 1 by Route 127.

6). Although the average rate of increase in the volume of car traffic accommodated on the Letete ferry service has been only about one percent per year during the past six years, the truck traffic has been increasing during the same period at a rate in excess of eight percent per year. Converting the traffic activity to an equivalent car basis, the overall average rate of growth during the 1977 - 1983 period was about 3.75 percent per year.

7). The traffic demand on the ferry service exhibits a pronounced peaking activity during the July/August period (see Figure 2.7).

8). Nearly 90 percent of the daily vehicular traffic accommodated on the Letete/Deer Island Ferry Service during the peak summer period occurs between 0930 hours and 1830 hours.

Chapter 3

9). For Park Options I and II, depending on the extent to which potential service improvements might modify the capacity constraints on the Letete Ferry Service, the total base traffic associated with the existing activities on the Island is expected to grow at a rate of approximately 2.5 - 3.5 percent per year.

10). For Park Options I and II the base traffic volumes on the primary access route to the Study Area (including Route 772 between St. George and Letete and Route 774 on Campobello) are not expected to increase to levels which present any concern from a traffic capacity perspective.

11). The incremental visitation levels associated with the three Marine Park options are summarized in Table 3.1. The typical peak season design day incremental two-way traffic generated as a result of the park visitation forecasts are summarized for the three park options in Table 3.2.

12). During the peak season, the existing Letete/Deer Island Ferry service is operating effectively at full capacity.

Chapter 4

13). The incremental traffic generated from the park visitation estimates prepared by the DPA Group would not result in sufficient additional traffic generation to necessitate infrastructure improvements in either of the major access routes or on the primary highway systems of Deer Island and Campobello. This excludes specific requirements for the access route to Greens Point for Park Option I and the Head Harbour Point access road for Park Options II and III.

14). Any significant increase in traffic volumes above the existing levels would result in a need for improvements to the capacity of the Letete/Deer Island Ferry service. This applies for both Options I and II. The impact of Option III on the Letete/Deer Island Ferry service would not be significant enough to warrant ferry service improvements due to park related traffic.

15). Figure 4.5 illustrates the estimated forecasts for the total two-way car equivalent traffic for Option I during an average design day in the peak period. This figure also illustrates the breakdown of the demand associated with the base component of traffic as well as that associated with the incremental requirements necessary to accommodate the park related traffic. Figure 4.6 illustrates similar data for Option II. Figures 4.7

shows the relative magnitude of the total traffic levels in Figures 4.5 and 4.6. It is evident from Figure 4.7 that, for purposes of practical general ferry service improvement requirements, the demand levels for Park Options I and II (Case C) are essentially the same.

16). A variety of alternatives were considered for improvements to the Letete/Deer Island Ferry service for Park Options I and II. The results of this analysis indicated that the existing service should be modified to include a new 24-car vessel at Year One (1988) of the Park implementation. This vessel should replace the existing D.L. MacLAREN and operate in parallel with the JOHN E. RIGBY. Details of the characteristics of the proposed replacement vessel are summarized in Table 4.3.

17). For Park Options I and II the longer term requirements for improvements necessary to accommodate the estimated growth in both the base traffic and the park related traffic would necessitate capacity improvements in excess of what could be accommodated only by the replacement of the D.L. MacLAREN with a larger (24-car) capacity ferry. Prior to the end of the 20-year planning horizon for this project, it is also anticipated that the JOHN E. RIGBY would have to be replaced with a larger vessel.

18). Although specific consideration was not given to the potential utilization of the JOHN E. RIGBY at the time when a second larger vessel would be required, one option for the use/disposition of the JOHN E. RIGBY would be potential application regarding upgrading of the private services provided from Deer Island Point to Welshpool and Eastport.

19). The Park Options I and II, capital costs associated with acquisition of new ferry vessels for the Letete/Deer Island Ferry service are summarized in Table 4.4. This table also includes an indication of the nominal costs associated with upgrading the marshalling areas at both the Letete and Butler Point terminals for this service.

20). A breakdown of the estimated ferry operating and maintenance costs (in terms of 1984 dollars) for Park Options I and II are summarized in Table 4.5. In addition to the direct ferry operating and maintenance costs noted in Table 4.5, there would also be costs associated with providing marshalling compound attendants at the Letete and Butler Point terminals during the summer season. These costs for 4 seasonal jobs (for June to September inclusive) are estimated to be $24 000 per year (1984 dollars). Over a twenty year period this would result in a total present value of $204 000 based on a 10 percent discount rate.

21). Although a preliminary evaluation of alternative terminal locations for the mainland terminal for Park Options I and II were carried out, the most cost-effective solution from both the initial cost and the operating cost perspective is to continue to utilize the existing terminal facility at Matthews Cove in Letete.

22). For Park Options I and II it would be necessary to expend about $400 000 regarding the access road from Letete Corner to Greens Point. (See Table 4.6).

23). For Park Options II and III, it would be necessary to expend about $150 000 to upgrade the access road to Head Harbour Point (northward from a point near the intersection of the road to Head Harbour Wharf).

Appendix A

24). As a result of the relatively low incremental volumes of traffic to Deer Island associated with the park concepts, there is not the requirement for major new bridge/causeway infrastructure. However, as noted during Phase I of the Study, various conceptual solutions for moving larger volumes of traffic to Deer Island were investigated. These solutions incorporated vehicular access to McMaster and Pendleton Islands as it was originally thought that such access would be required in the park concept.

25). The assessment of the technical feasibility of constructing new causeways, ferry terminals, etc., included a preliminary review of the sites' climatology and the environmental factors which would be acting on the potential structures. This review resulted in the following:

Tidal Range (Large Tide)	8.0+ m
Significant Wave Height	3.0+ m
Wave Period	7 to 10+ sec.
Current Velocity, Letete Passage	3.66+ m/sec.
Current Velocity, Little Letete and Pendleton Passages	1.68+ m/sec.

26). With respect to the primary crossing between the Mainland and McMaster Island, it was determined that as a result of the very high tidal currents, the only practical solution would involve the use of a self-propelled ferry. A cable ferry would not be practical in the large tidal cross currents of Letete Passage.

27). It was determined that although technically possible, the fishing industry would be adversely affected if the passageways between Deer Island and Pendleton Island and between Pendleton and McMaster Islands were closed. As such, it was concluded that major bridge structures would be required between these islands.

28). The conceptual infrastructure developed, to accommodate a major increase in traffic to Deer Island via McMaster and Pendleton Islands, included a new highway/causeway system between Letete and Hoyt Island, a new ferry terminal on the southern end of Hoyt Island complete with armour stone breakwaters, a new self-propelled ferry system to Ship Harbour on McMaster Island, new roadway systems on McMaster, Pendleton and Deer Islands and new bridge structures connecting McMaster and New Ireland, New Ireland and Pendleton and Pendleton and Deer Islands (see Figure A.10 for routing).

29). The capital cost estimate of the new infrastructure may be summarized as follows:

New Highway/Causeway Systems	$ 3.8 M
New Ferry Terminal @ Hoyt and MacMaster Islands Including Breakwaters	5.5 M
New Ferry System (2 @ $4.1 M)	8.2 M
New Bridges	14.5 M
Total (1984 dollars)	$32.0 M

5.2 Conclusions

1). Based on the park visitation estimates prepared by the DPA Group, the incremental traffic demand for all three park options on the existing highways accessing the park elements and those within the park is relatively insignificant from a vehicular capacity perspective. Given the incremental traffic volumes estimated during the peak season, there would be no justification for improvements in the highway infrastructure within and accessing the park area (except for upgrading access roads to Greens Point and Head Harbour Point as appropriate, depending on the Park Option).

2). On the other hand, the existing ferry service to Deer Island does not have the surplus capacity necessary to accommodate the additional demand which would be associated with the park traffic for Options I and II. For these park options, an improved level of service on the Letete/Deer Island ferry crossing is required. The capacity of such improved service should incorporate the ability to accommodate the park related traffic and the existing demand which is supressed by the current level of ferry service.

3). The details and associated costs of transportation improvements required for each of the three park development options are summarized in Table 4.6.

4). For Park Options I and II it is recommended that the Letete/Deer Island Ferry service should be upgraded on a schedule generally compatible with the implementation schedule for the Marine Park. The ferry service upgrading should involve replacement of the D. L. MacLAREN ferry vessel in Year one of the park implementation (assumed to be 1988). This vessel should be replaced with a new 24-car capacity ferry. It is also anticipated that a second 24-car capacity ferry would be required to replace the John E. Rigby by about Year 2000.

6). For Park Options I and II, the estimated capital costs (see Table 4.6) of the new ferries would be equal to 4.1 million dollars each (1984 dollars). In addition to these initial capital costs, there is a requirement for expenditures of about $100 000 each to upgrade the marshalling areas at both the Letete and Butler Point terminals. As well, provision of a marshalling attendant should be provided at both ferry terminal facilities during the summer period. The estimated cost of the terminal marshalling attendants (four in total involving two shifts, 1 each shift at each terminal) is about $24 000 per year (1984 dollars).

7). In addition to the operating costs for marshalling attendants, there will also be increases in the annual ferry operating and maintenance costs. These incremental annual costs are expected to be $240 000 until the JOHN E. RIGBY is replaced with a new vessel (about Year 2000). After that time, the incremental annual operating and maintenance costs will be about $300 000 in excess of the current level*.

---

* All costs are expressed in constant 1984 dollars.

8). The cost of upgrading the access road to Greens Point for Options I and II is about $400 000. (See Table 4.6).

9). The cost of upgrading the access road to Head Harbour Point for Options II and III is about $150 000. (See Table 4.6).

APPENDIX A

EVALUATION OF BRIDGE/CAUSEWAY FERRY LINKAGE POSSIBILITIES BETWEEN DEER ISLAND AND THE MAINLAND

APPENDIX A

EVALUATION OF BRIDGE/CAUSEWAY FERRY LINKAGE POSSIBILITIES BETWEEN DEER ISLAND AND THE MAINLAND

A.1 Introduction

As noted in the introductory chapter to this report, a substantial amount of work on the Transportation Analyis was conducted prior to formulation of the final set of three park development options. Early indications of potential development concepts for the park indicated a high probability of the need for a connection between Deer Island and the mainland involving bridges and/or causeways. Therefore, an evaluation of the possible implications and requirements for such a level of service was undertaken. Even though the demand inherent in the final set of park options would not be anywhere near the capacity of such a fixed highway linkage, the client has requested that this material be documented for potential future reference.

A.2 Infrastructure Requirements

As a result of the relatively low incremental volumes of traffic to Deer Island associated with the final development park concepts, there is not the requirement for major new fixed transportation infrastructure. However, prior to receiving potential park visitation forecasts from Consultants involved with other aspects of the park feasibility analysis, various conceptual solutions for moving larger volumes of traffic to Deer Island were investigated. In particular, these solutions incorporated vehicular access to McMaster and Pendleton Islands as it was originally thought that such access could be required.

It should be clearly understood that the following concepts should be considered as preliminary and the cost estimates prepared are only "ball park" estimates. They were prepared without the benefit of field programs involving modern current measurement studies and bathymetric surveys. Sophisticated mathematical and/or physical model investigations concerning the wave/current climate were not made. Furthermore, the quantities were based on available mapping without the benefit of any geotechnical information. In addition, no efforts were made to fully assess the merits of various types of bridge structures which would best solve what is seen to be major bridge design problems resulting from severe tidal currents, difficult topography, extreme channel depths and the requirement for very long spans.

In summary, the conceptual infrastructure which would be required to accommodate a major increase in traffic to Deer Island via McMaster and Pendleton Island would have involved a new highway/causeway system between Letete and Hoyt Island, a new ferry terminal on the southern end of Hoyt Island complete with armour stone breakwaters for wave and current protection, a new self-propelled ferry system to Ship Harbour on McMaster Island, new roadway systems on McMaster, Pendleton and Deer Islands and new bridge structures connecting McMaster and New Ireland, New Ireland and Pendleton, and Pendleton and Deer Island (See Figure A.14 of this Appendix for an overview of the area and Figure A.10 in Section A.5 for the proposed routing).

The capital cost estimate (in 1984 dollars) of the new infrastructure required to achieve such a fixed land linkage may be summarized as follows:

New Highway/Causeway System to Hoyt Island	$ 2.0 M
New Ferry Terminal at Hoyt Island Including Breakwaters	$ 3.3 M
New Ferry System (2 @ $ 4.1 M)	$ 8.2 M
New Ferry Terminal at McMaster Island	$ 2.2 M
New Highway on McMaster Island	$ 0.8 M

New Bridge, (McMaster to New Ireland)	$ 9.0 M
New Bridge, (New Ireland to Pendleton)	$ 2.0 M
New Highway on Pendleton Island	$ 0.5 M
New Bridge from Pendleton to Deer Island	$ 3.5 M
New Highway on Deer Island to Stuart Town	$ 0.5 M
Total	$32.0 M

Prior to a more detailed discussion on the above mentioned infrastructure, the following section of this report outlines the site's climatology and the environmental forces acting on the structures which would have been proposed had, a). more tourism traffic been inherent in the Park development options and/or b). vehicular traffic to McMaster and Pendleton Islands been a requirement for the proposed park.

A.3 Site Climatology and Environmental Factors

A.3.1 Tidal Climate

Structures located in the Bay of Fundy are subjected to some of the world's largest semi-diurnal tides. In the Quoddy Region, the maximum tide is approximately 8.1 m. Mean tidal ranges vary from 6.3± m at the head of the St. Croix estuary to 5.5± m at North Head, Grand Manan. For the Letete area, large and mean tides were assumed as follows:.

Large Tide	8.0± m
Mean Tide	5.7± m

For the purposes of this investigation, a large tide was used to determine the minimum crest elevation for the quarry run (core material) with respect to the design and quantity estimates for elements of the infrastructure, including the rubble mound protective breakwaters and causeway structures.

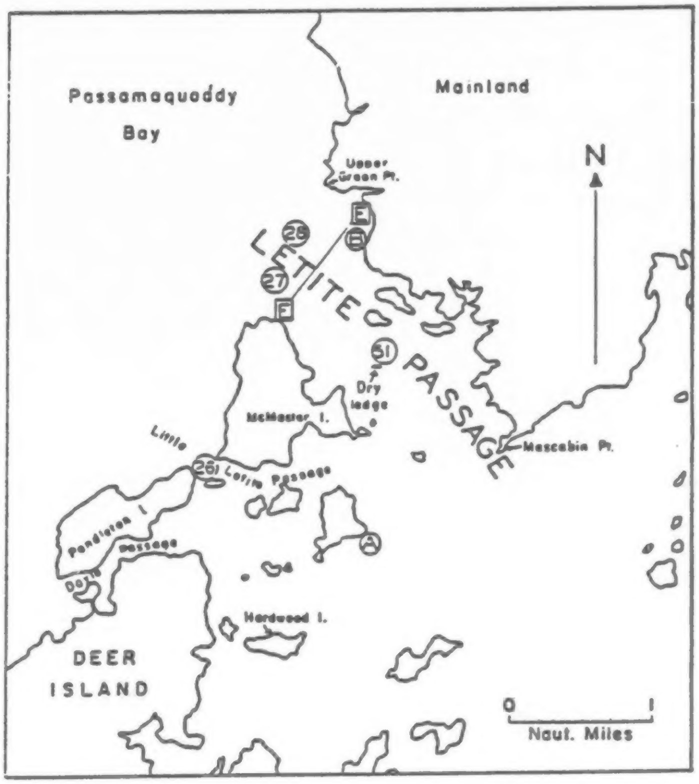
As will be seen later in this Appendix, tides of the magnitude experienced in the Fundy Isles region can create major tidal currents having significant effects on the design of structures.

A.3.2 Currents and Non-Tidal Drift

As a result of the tremendous volume of water flooding in an out of the Passamaquoddy Bay twice daily, high tidal currents are produced in the passages and channels forming the Fundy Isles. This phenomenon is readily evidenced by examining aerial photographs and by simply observing the water surface patterns which can be viewed while making the Letete/Deer Island Ferry passage.

Qualitative assessment of the tidal flows and currents were based on previous studies conducted by Trites and MacGregor (7) and Forrester (5) (Numbered references are listed at the end of this Appendix). Trites and MacGregor, using the electromagnetic induction method, measured flows of water in the various passages in the Fundy Isles region. Table A.1 describes the flows (based on the volume and % of total) at various times during the tidal cycle. In summary, based on the electromagnetic induction method, it was determined that Western Passage supplies approximately 61% of the water entering Passamaquoddy Bay, Letete Passage approximately 34% and Little Letete and Pendleton Passages approximately 5%. As such, structures and ferry operations are affected by massive volumes of water flowing through the passages between the mainland and Deer Island and to a lesser extent between the Islands themselves.

Forrester conducted a series of current measurements in 1957 using current meters suspended over the sides of anchored vessels. Station numbers 26, 27, 28 and 51 are of particular interest to this study (See Figure A.1).


Passamaquoddy
Bay
Mainland
Upper Green Pt.
N
LETITE PASSAGE
E
28
27
F
51
Dry ledge
McMaster I.
Little Letite Passage
26
Mascabin Pt.
A
Pendleton I.
Passage
Doyle
Hardwood I.
DEER ISLAND
0
1
Naut. Miles

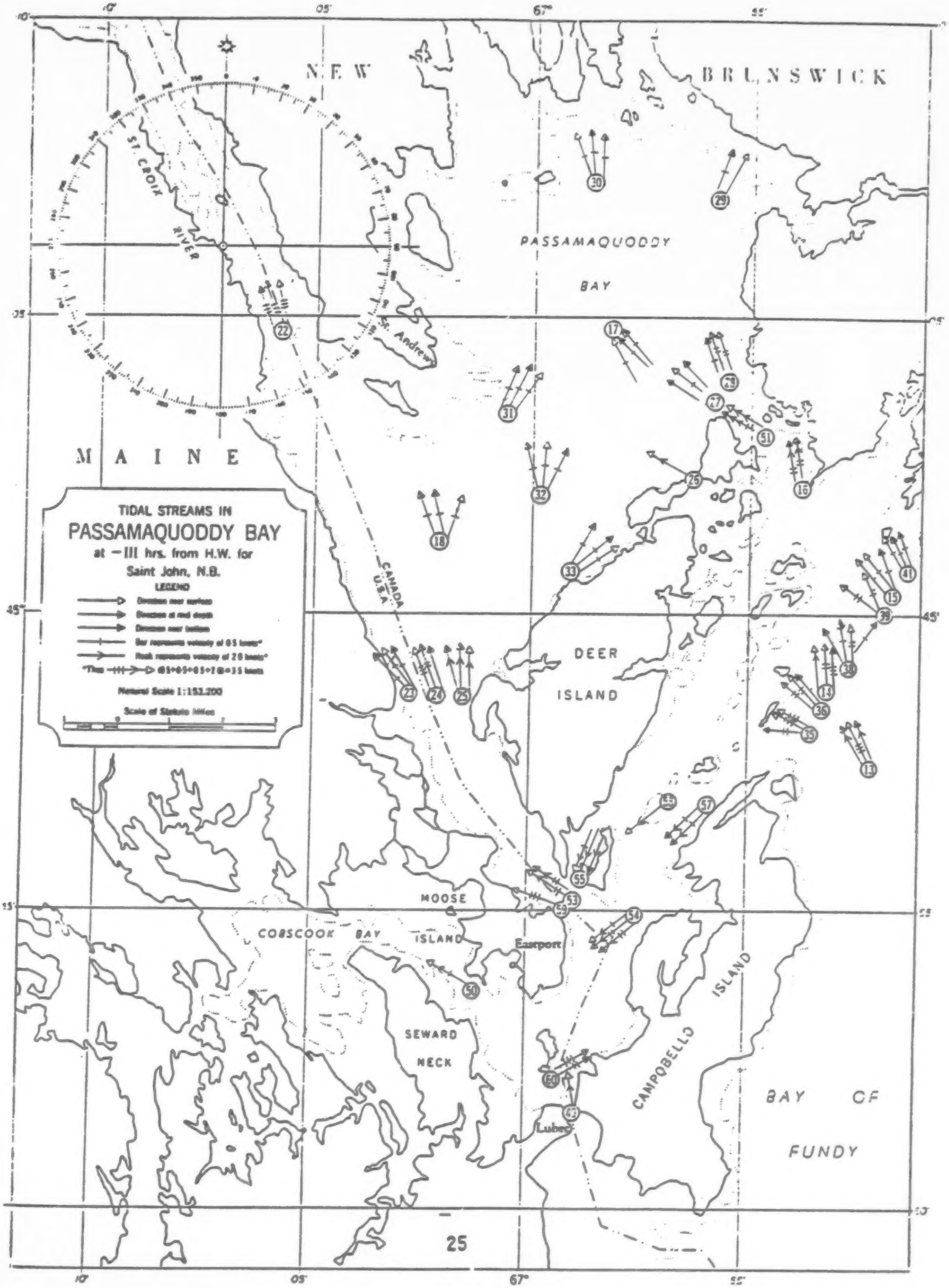
Letite Passage showing location of installation and current measurement stations.

Minimum cross-sectional areas in passages for each hour of tide.

Section		High water	HW+1	HW+2	HW+3	HW+4	HW+5	HW+6
Western Passage	(ft² × 10^{5})	3.58	3.49	3.38	3.28	3.18	3.08	2.98
	(% of total)	57	58	59	60	62	63	65
Letite Passage	(ft² × 10^{5})	2.17	2.06	1.95	1.84	1.73	1.62	1.51
	(% of total)	35	34	34	34	33	33	33
Little Letite and Doyle Passages	(ft² × 10^{5})	0.53	0.46	0.38	0.32	0.25	0.18	0.11
	(% of total)	8	8	7	6	5	4	2
Total	(ft² × 10^{5})	6.28	6.01	5.71	5.44	5.16	4.88	4.60
	Percentage	100	100	100	100	100	100	100

(From Trites and MacGregor (7))

Table A.1



TIDAL STREAMS IN
PASSAMAQUODDY BAY
at −III hrs. from H.W. for
Saint John, N.B.
LEGEND
Direction near surface
Direction at mid depth
Direction near bottom
Bar represents velocity of 0.5 knots*
Hook represents velocity of 2.0 knots*
*Thus 0.5+0.5+0.5+2.0=3.5 knots
Natural Scale 1:151,200
Scale of Statute Miles
NEW
BRUNSWICK
MAINE
PASSAMAQUODDY
BAY
ST. CROIX
RIVER
St. Andrews
CANADA
U.S.A.
DEER
ISLAND
MOOSE
ISLAND
COBSCOOK BAY
Eastport
SEWARD
NECK
CAMPOBELLO
ISLAND
Lubec
BAY OF
FUNDY
10'
05'
67°
55'
45°
30
29
22
17
28
27
31
51
16
25
32
18
33
41
15
39
38
23
24
14
36
35
13
56
57
55
53
59
54
50
60
62

(From Forrester (5))

Figure A.1

Data from these stations are indicated on Tables A.2 and A.3 and are represented graphically on Figures A.1 and A.2, which indicate tidal streams at high water +3 hours and high water -3 hours, which are the times of maximum flows.

As these figures indicate, the maximum observed current (including tidal and residual) at Little Letete passage was 3.74 ft./sec. (1.14 m/sec) at the 5m depth. Since Forrester's data has all been reduced proportionally to a range of tide of 21.0 ft. (6.4 m) at Saint John, maximum currents may be approximated by ratioing to an extreme tide of 31 ft. (9.45 m). As such, for the purposes of this investigation the maximum current at Little Letete was assumed to be 5.5 ft./sec (1.68 m/sec.).

Similarly, the maximum observed current at Letete Passage itself was 8.11 ft./sec. (2.47 m/sec.). This again may be ratioed to 11.97 ft./sec. (3.65 m/sec.) based on an extreme tide.

Review of several of the studies included in the references listed in this Appendix indicates that the current profile is relatively constant with depth, except near the seabed. However, it is probable that surface velocities may in fact be somewhat greater than those observed at the 5 m depth. Similarly, it should be borne in mind that the current metering devices used in 1957 were less than ideal and as such some caution is warranted in the use of this data.

A.3.3 Wind Climatology

Extrapolation curves for extreme wind predictions from two (2) previous Eastern Designers & Company Limited reports (3)(4) dealing with the Bay of Fundy wind climatology were reviewed. Figures A.3, A.4, A.5 and A.6 indicate wind predictions for Tiner Point, Pt. Lepreau, Southwest Head and Yarmouth, respectively.

It should be noted that the Southwest Head wind predictions were based on limited data and, as such, cannot be considered entirely reliable.

Tidal Stream and Residual Current Observations in Passamaquoddy Bay and the Bay of Fundy: Reference Port is Saint John, N. B.

Station No. 25 Passamaquoddy Bay
June 18-19, 1958

Depth	5m		10m		25m	
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W.-VI	0.50	120	0.35	104	0.58	155
H.W.-V	1.51	022	1.43	011	1.35	351
H.W.-IV	2.88	001	2.74	355	2.84	346
H.W.-III	3.26	359	3.13	358	3.41	345
H.W.-II	1.92	357	1.92	351	2.13	348
H.W.-I	0.36	322	0.71	307	1.23	350
High Water	0.71	230	0.16	240	0.54	336
H.W.+I	1.40	213	0.96	208	0.21	177
H.W.+II	1.65	202	1.73	197	1.43	168
H.W.+III	1.86	189	2.28	180	2.49	168
H.W.+IV	2.11	170	2.55	164	3.07	169
H.W.+V	1.99	158	2.14	161	2.70	168
H.W.+VI	1.07	143	0.91	140	1.34	165
Residual	1.05	194	0.85	194	0.45	190

Station No. 26 Passamaquoddy Bay
June 27-28, 1958

Depth	5m					
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'.
H.W.-VI	1.04	300				
H.W.-V	2.71	300				
H.W.-IV	3.40	300				
H.W.-III	3.74	300				
H.W.-II	3.50	300				
H.W.-I	2.18	300				
High Water	1.52	120				
H.W.+I	3.10	120				
H.W.+II	3.40	120				
H.W.+III	3.36	120				
H.W.+IV	2.98	120				
H.W.+V	1.92	120				
H.W.+VI	0.00	-				
Residual	0.13	300				

Station No. 27 Passamaquoddy Bay
July 10-11, 1958

Depth	5m		10m		20, 30m	
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W.-VI	1.10	235	0.92	230	0.51	234
H.W.-V	0.74	276	0.79	265	0.65	273
H.W.-IV	0.75	295	0.63	292	0.56	288
H.W.-III	1.15	308	0.24	316	0.38	302
H.W.-II	2.06	318	1.59	332	0.78	320
H.W.-I	0.75	330	0.95	346	0.73	340
High Water	0.40	011	0.64	007	0.61	003
H.W.+I	1.06	048	0.61	040	0.38	020
H.W.+II	0.87	076	0.81	068	0.32	047
H.W.+III	1.43	107	1.28	119	1.28	091
H.W.+IV	1.73	140	1.52	150	1.28	132
H.W.+V	1.38	167	1.01	170	1.05	166
H.W.+VI	1.15	210	0.88	208	0.72	210
Residual	0.31	008	0.07	352	0.09	055

Station No. 28 Passamquoddy Bay
July 11, 1958

Depth	5m		20m		30m	
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W.-VI	0.93	340	1.23	340	0.65	340
H.W.-V	1.32	340	1.27	340	1.08	340
H.W.-IV	1.45	340	0.54	340	0.84	340
H.W.-III	1.32	340	1.17	340	0.78	340
H.W.-II	1.08	340	1.38	340	0.78	340
H.W.-I	0.78	340	0.75	340	0.64	340
High Water	0.08	160	0.06	160	0.09	160
H.W.+I	1.68	160	1.55	160	1.43	160
H.W.+II	1.80	160	1.69	160	1.40	160
H.W.+III	1.67	160	1.57	160	1.04	160
H.W.+IV	1.44	160	1.26	160	0.67	160
H.W.+V	0.69	160	0.57	160	0.16	160
H.W.+VI	0.67	340	0.64	340	0.26	340
Residual	0.06	340	0.05	340	0.07	340

Station No. 29 Passamaquoddy Bay
August 14, 1958

Depth	2m		5m		10m	
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W.-VI	0.07	235	0.30	229	0.37	245
H.W.-V	0.16	017	0.29	002	0.19	316
H.W.-IV	0.33	038	0.35	018	0.30	003
H.W.-III	0.23	047	0.37	027	0.57	020
H.W.-II	0.23	069	0.56	046	0.59	030
H.W.-I	0.19	150	0.42	062	0.41	040
High Water	0.19	240	0.07	180	0.24	064
H.W.+I	0.18	250	0.50	192	0.13	120
H.W.+II	0.15	248	0.46	193	0.34	173
H.W.+III	0.00	-	0.54	196	0.46	197
H.W.+IV	0.14	042	0.49	198	0.49	211
H.W.+V	0.29	211	0.13	205	0.49	215
H.W.+VI	0.18	220	0.40	215	0.43	225
Residual	0.23	215	0.10	192	0.17	138

Station No. 30 Passamaquoddy Bay
August 11, 1958

Depth	5m		10m		15, 20m	
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W.-VI	0.63	220	0.13	181	0.52	255
H.W.-V	0.56	334	0.33	338	0.32	312
H.W.-IV	0.66	339	0.63	318	0.43	346
H.W.-III	0.63	340	0.51	360	0.88	354
H.W.-II	0.73	348	0.95	018	0.60	359
H.W.-I	0.51	024	0.55	002	0.35	008
High Water	0.46	073	0.28	224	0.29	038
H.W.+I	0.61	117	0.23	173	0.12	125
H.W.+II	0.67	148	0.41	165	0.26	184
H.W.+III	0.71	172	0.42	168	0.63	168
H.W.+IV	0.58	190	0.72	179	0.73	132
H.W.+V	0.52	198	0.26	154	0.85	164
H.W.+VI	0.78	209	0.34	166	0.71	222
Residual	0.08	040	0.16	240	0.17	067

(From Forrester (5))

Table A.2

Tidal Stream and Residual Current Observations in Passamaquoddy Bay and the Bay of Fundy: Reference Port is Saint John, N. B.

Station No. 48 Bay of Fundy
July 17-18, 1958

Depth	5m		25m		50, 60m	
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W. -VI	1.28	266	0.77	260	0.53	110
H.W. -V	1.12	045	1.46	059	1.65	070
H.W. -IV	3.01	050	3.39	060	2.74	064
H.W. -III	4.30	051	3.92	063	3.01	062
H.W. -II	4.12	052	3.43	063	2.73	060
H.W. -I	3.07	059	2.44	036	1.47	043
High Water	1.61	096	0.79	026	0.59	352
H.W. +I	1.37	195	1.32	244	1.38	253
H.W. +II	3.01	225	2.84	240	2.36	246
H.W. +III	3.75	230	3.55	238	3.02	245
H.W. +IV	3.75	238	3.30	237	2.82	245
H.W. +V	3.01	248	2.60	236	2.24	228
H.W. +VI	1.85	251	1.46	242	1.02	157
Residual	0.17	146	0.33	291	0.09	319

Station No. 49 Passamaquoddy Bay
July 15, 1958

Depth	5m					
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W. -VI	4.47	345				
H.W. -V	4.60	345				
H.W. -IV	4.28	345				
H.W. -III	3.20	345				
H.W. -II	1.45	345				
H.W. -I	2.62	165				
High Water	3.20	165				
H.W. +I	3.21	165				
H.W. +II	3.20	165				
H.W. +III	2.98	165				
H.W. +IV	2.41	165				
H.W. +V	1.10	165				
H.W. +VI	4.02	345				
Residual	0.94	165				

Station No. 50 Cobscook Bay
August 27, 1958

Depth	5m					
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W. -VI	1.78	120				
H.W. -V	0.84	300				
H.W. -IV	3.00	300				
H.W. -III	4.40	300				
H.W. -II	4.90	300				
H.W. -I	3.76	300				
High Water	2.24	300				
H.W. +I	0.50	120				
H.W. +II	3.15	120				
H.W. +III	4.30	120				
H.W. +IV	4.32	120				
H.W. +V	3.66	120				
H.W. +VI	2.48	120				
Residual	0.74	120				

Station No. 51 Passamaquoddy Bay
July 8-9, 1957

Depth	5m					
Lunar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W. -VI	0.56	126				
H.W. -V	5.60	306				
H.W. -IV	7.63	306				
H.W. -III	8.11	306				
H.W. -II	7.63	306				
H.W. -I	5.60	306				
High Water	2.03	126				
H.W. +I	5.84	126				
H.W. +II	7.54	126				
H.W. +III	7.88	126				
H.W. +IV	7.03	126				
H.W. +V	3.70	126				
H.W. +VI	0.56	126				
Residual	0.54	306				

Station No. 51 Passamaquoddy Bay
August 28, 1958

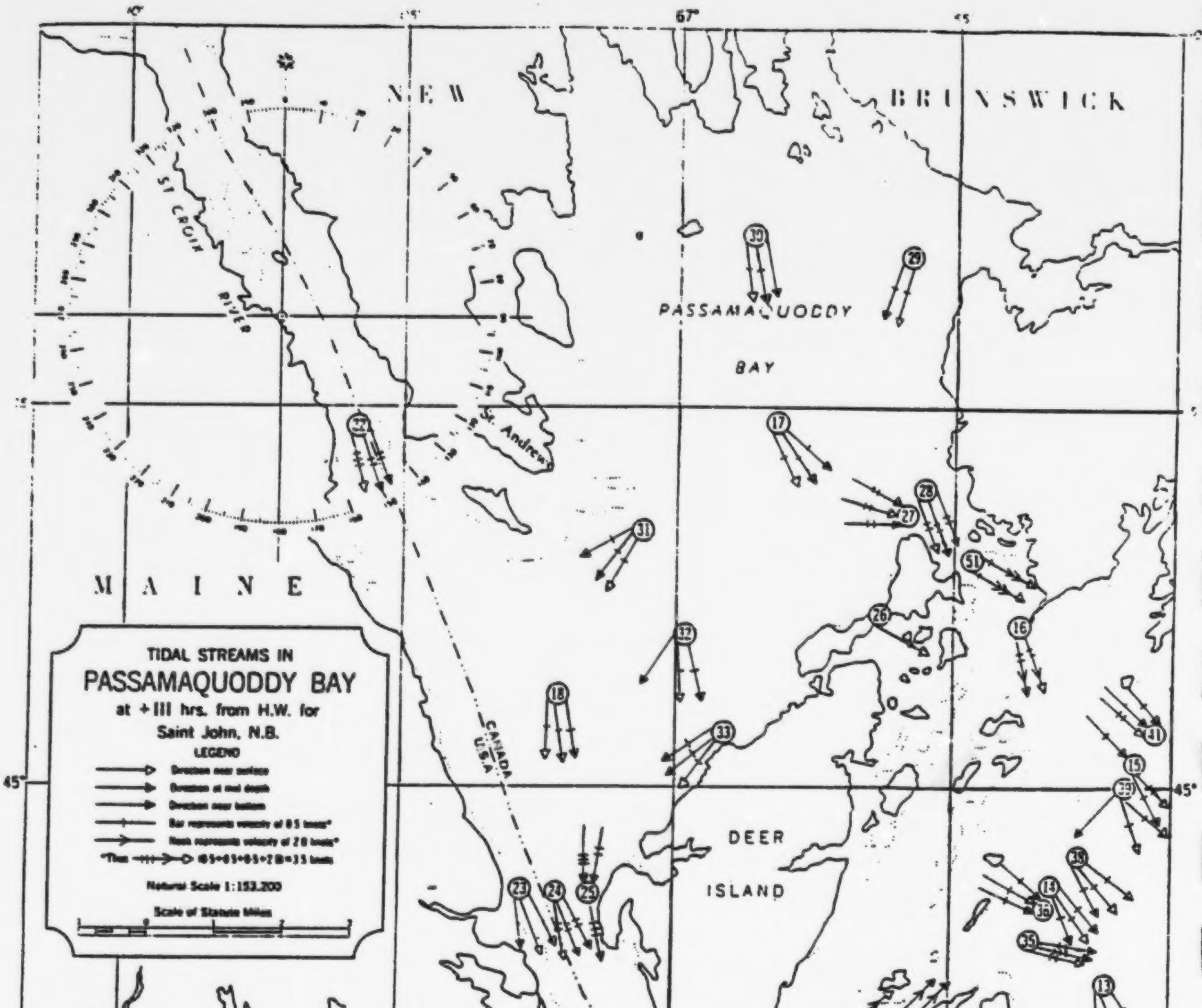
Depth	2m		4, 17m			
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W. -VI	1.94	300	1.65	300		
H.W. -V	6.76	300	6.70	300		
H.W. -IV	7.30	300	7.52	300		
H.W. -III	7.96	300	7.79	300		
H.W. -II	7.38	300	6.55	300		
H.W. -I	5.58	300	3.51	300		
High Water	0.97	120	0.25	300		
H.W. +I	6.06	120	5.96	120		
H.W. +II	6.79	120	7.32	120		
H.W. +III	6.89	120	7.60	120		
H.W. +IV	6.81	120	6.92	120		
H.W. +V	6.58	120	5.00	120		
H.W. +VI	1.57	120	1.33	120		
Residual	0.28	300	0.18	300		

Station No. 52 Passamaquoddy Bay
May 21-22-23, 1957

Depth	5m					
Solar Hours	ft/sec	Dir'n	ft/sec	Dir'n	ft/sec	Dir'n
H.W. -VI	4.43	350				
H.W. -V	6.43	350				
H.W. -IV	5.91	350				
H.W. -III	4.63	350				
H.W. -II	1.76	350				
H.W. -I	2.74	170				
High Water	4.63	170				
H.W. +I	5.35	170				
H.W. +II	4.88	170				
H.W. +III	3.85	170				
H.W. +IV	2.27	170				
H.W. +V	0.09	170				
H.W. +VI	2.67	350				
Residual	2.00	170				

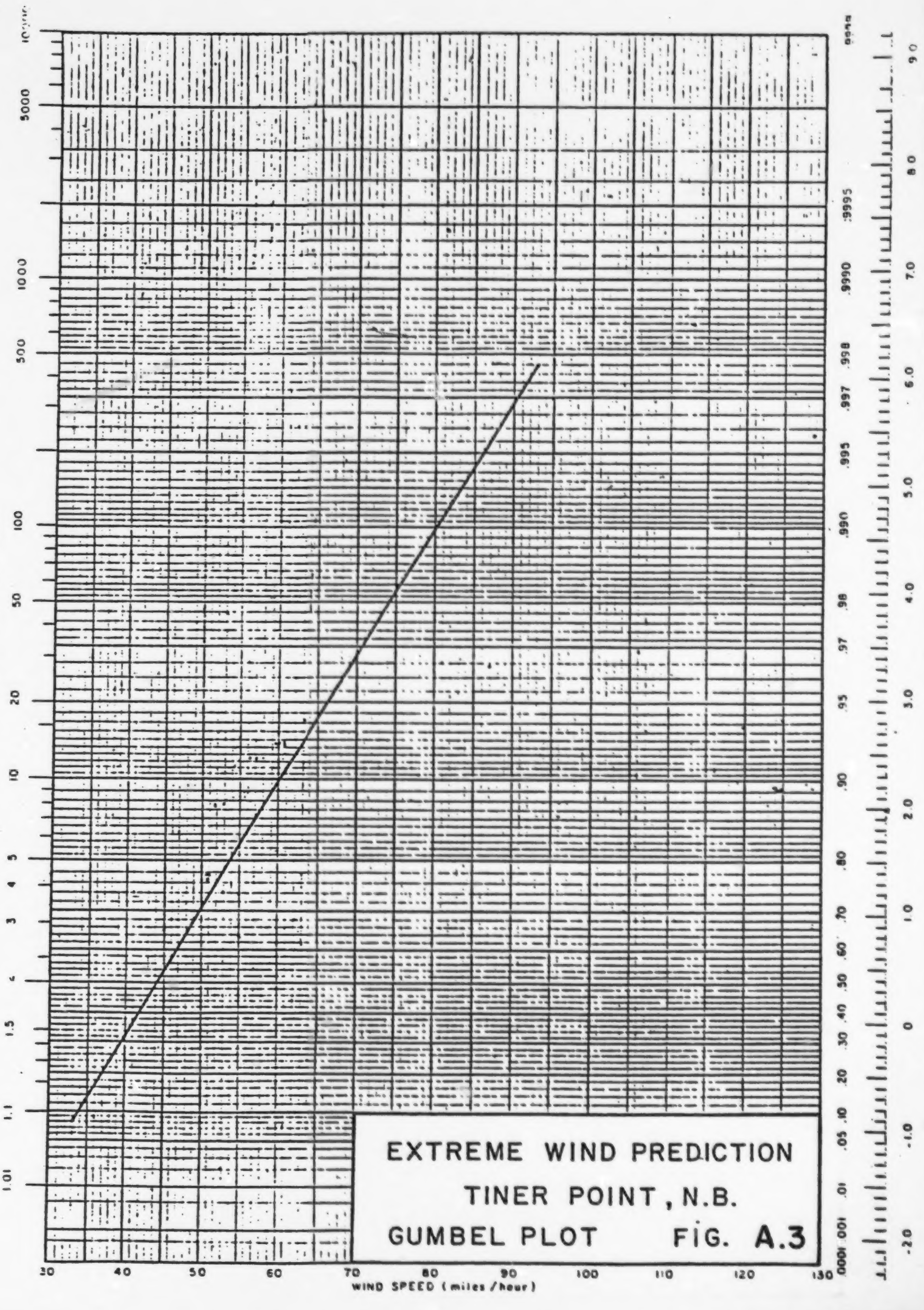
(From Forrester (5))

Table A.3

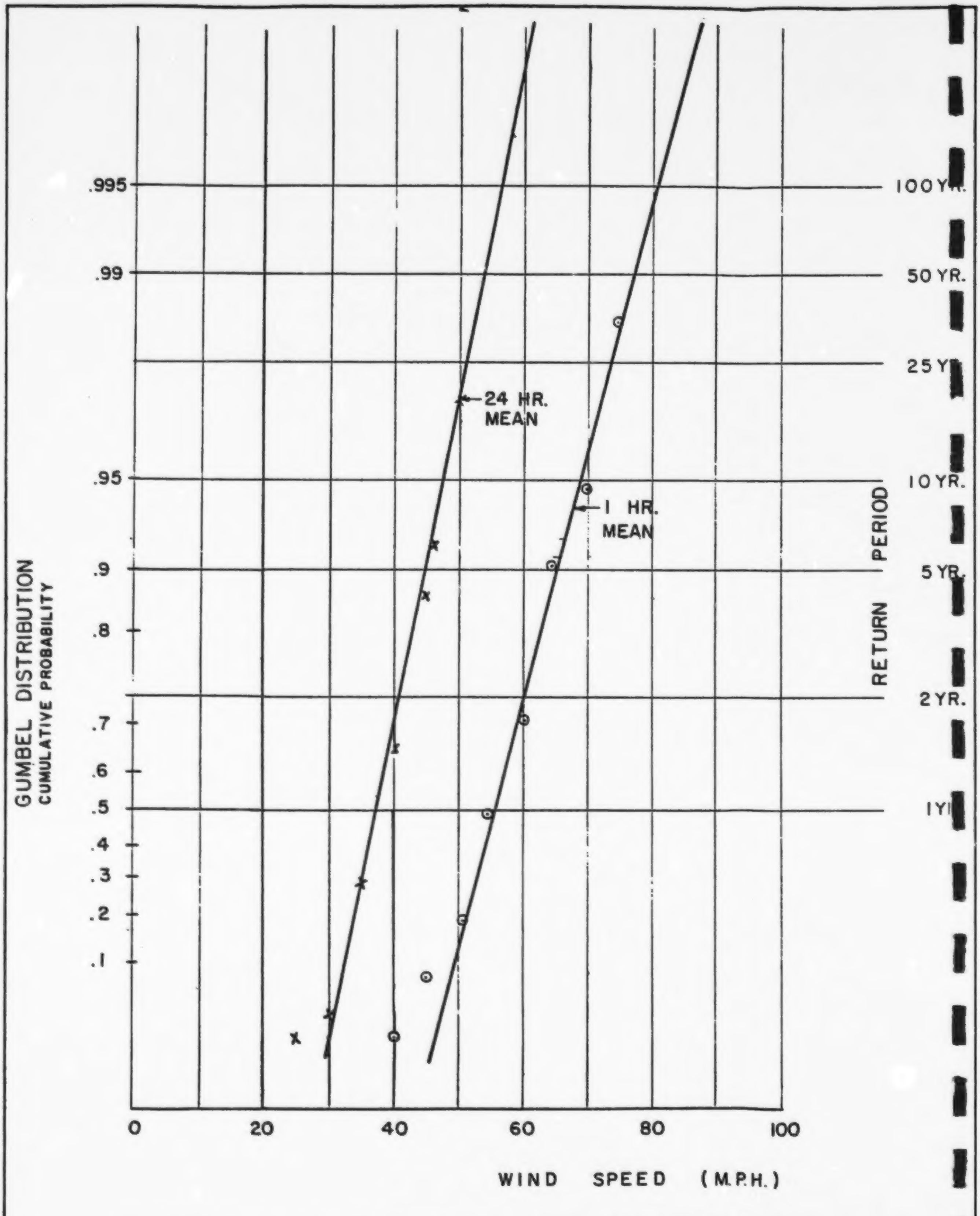

TIDAL STREAMS IN
PASSAMAQUODDY BAY
at +III hrs. from H.W. for
Saint John, N.B.
LEGEND
Direction near surface
Direction at mid depth
Direction near bottom
Bar represents velocity of 0.5 knots*
Head represents velocity of 2.0 knots*
*Thus (0.5+0.5+0.5+2.0)=3.5 knots
Natural Scale 1:153,200
Scale of Statute Miles
NEW BRUNSWICK
MAINE
PASSAMAQUODDY BAY
ST CROIX RIVER
St. Andrews
CANADA
U.S.A.
DEER ISLAND
MOOSE ISLAND
COBSCOOK BAY
Eastport
SEWARD NECK
Lubec
CAMPOBELLO ISLAND
BAY OF FUNDY
67°
10'
05'
55'
45°
50'

(From Forrester (5))

Figure A.2

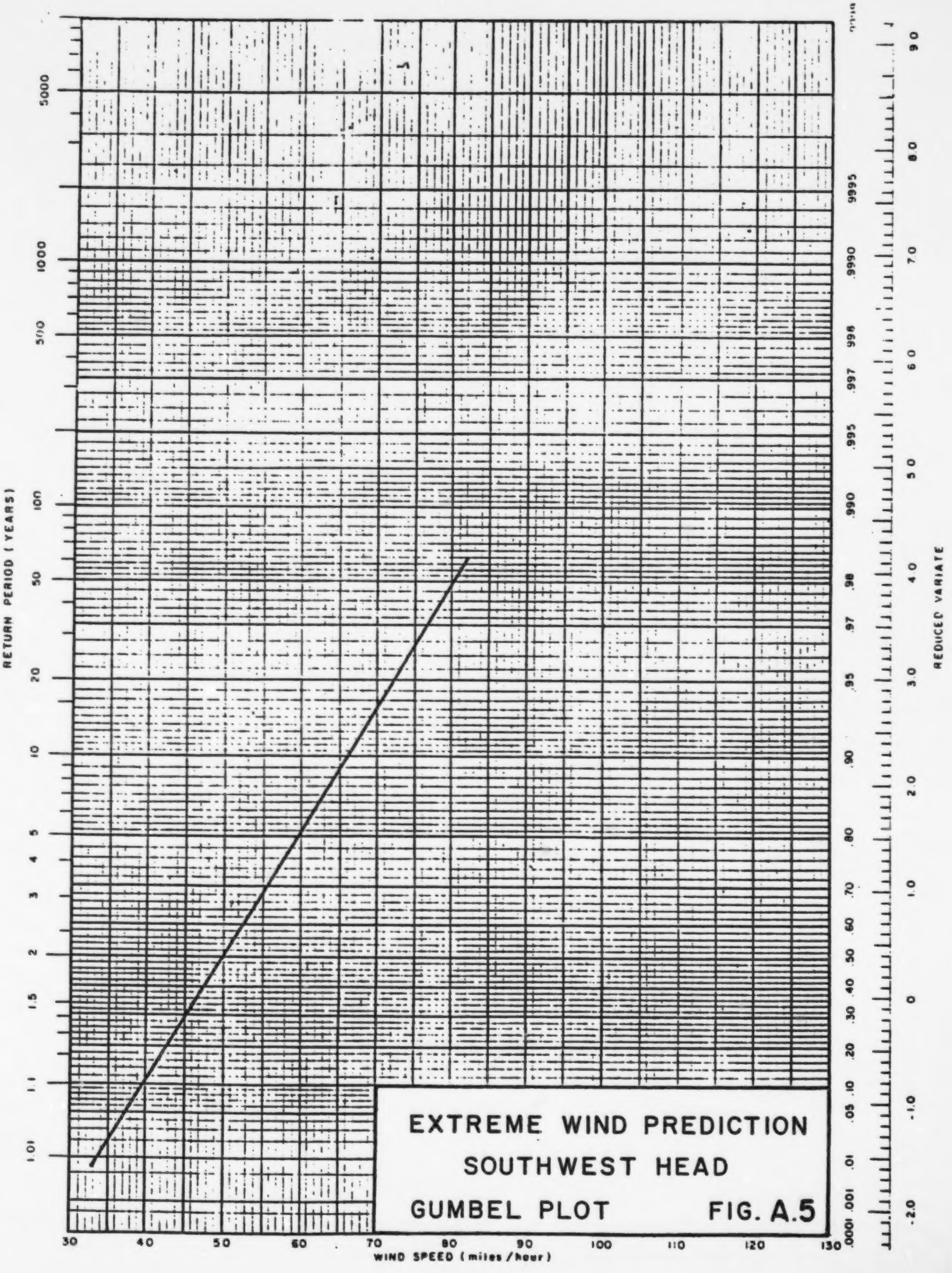


EXTREME WIND PREDICTION
TINER POINT, N.B.
GUMBEL PLOT FIG. A.3



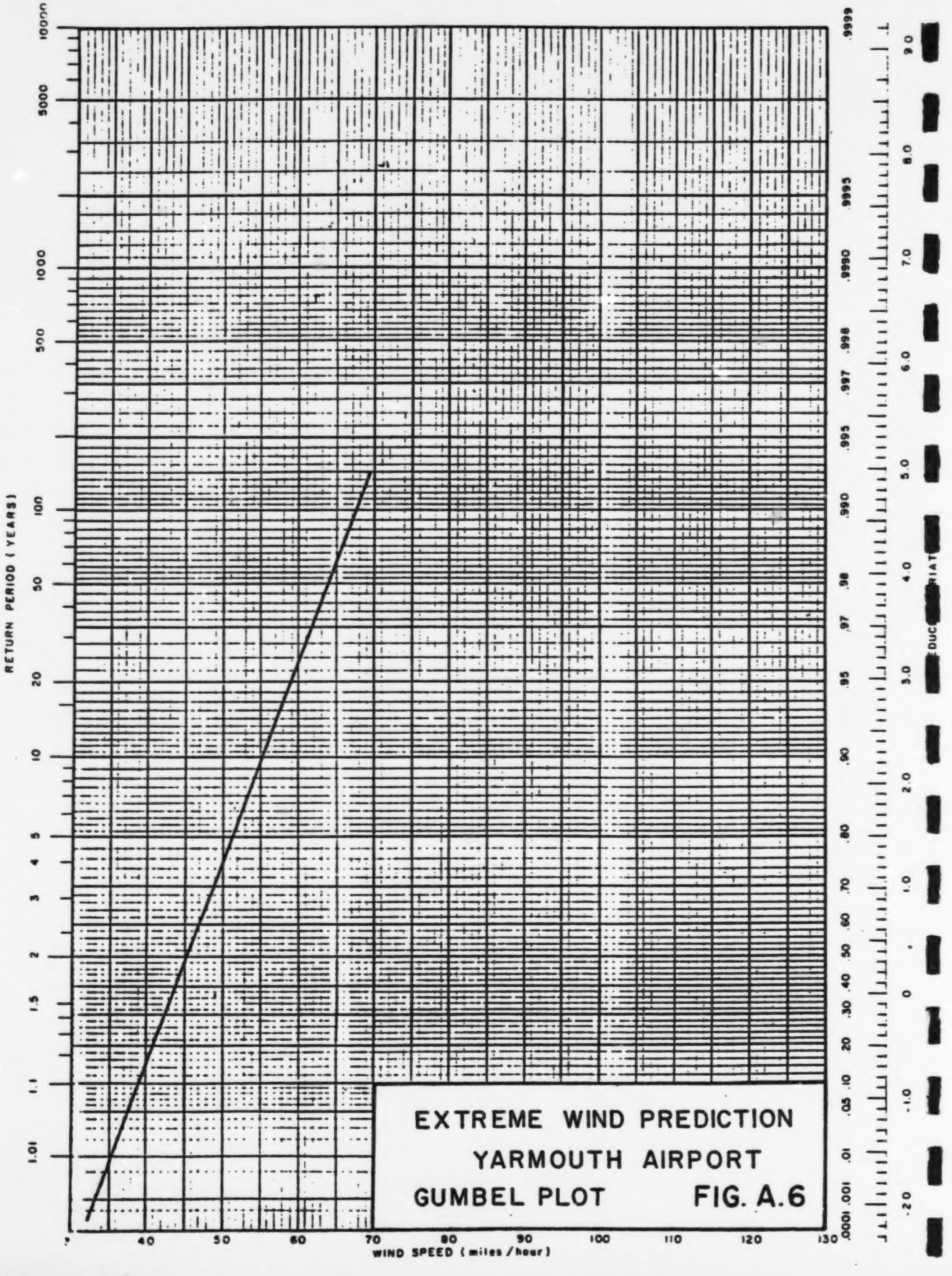
PT. LEPREAU EXTREME WIND PREDICTIONS

FIG. A.4



EXTREME WIND PREDICTION
SOUTHWEST HEAD
GUMBEL PLOT

FIG. A.5



EXTREME WIND PREDICTION
YARMOUTH AIRPORT
GUMBEL PLOT

FIG. A.6

The curves tend to indicate that wind speeds vary depending on locations within the Bay of Fundy. In particular, exposed locations such as Pt. Lepreau and Southwest Head experience more severe conditions.

The curves are presented to indicate that sole use of one wind station for wave hindcasting may be somewhat in question and that the entire wind regime possibly should be investigated with respect to any detailed wave hindcast study. For the purposes of this preliminary investigation, it was decided to use a combination of the Pt. Lepreau, Southwest Head and Yarmouth data.

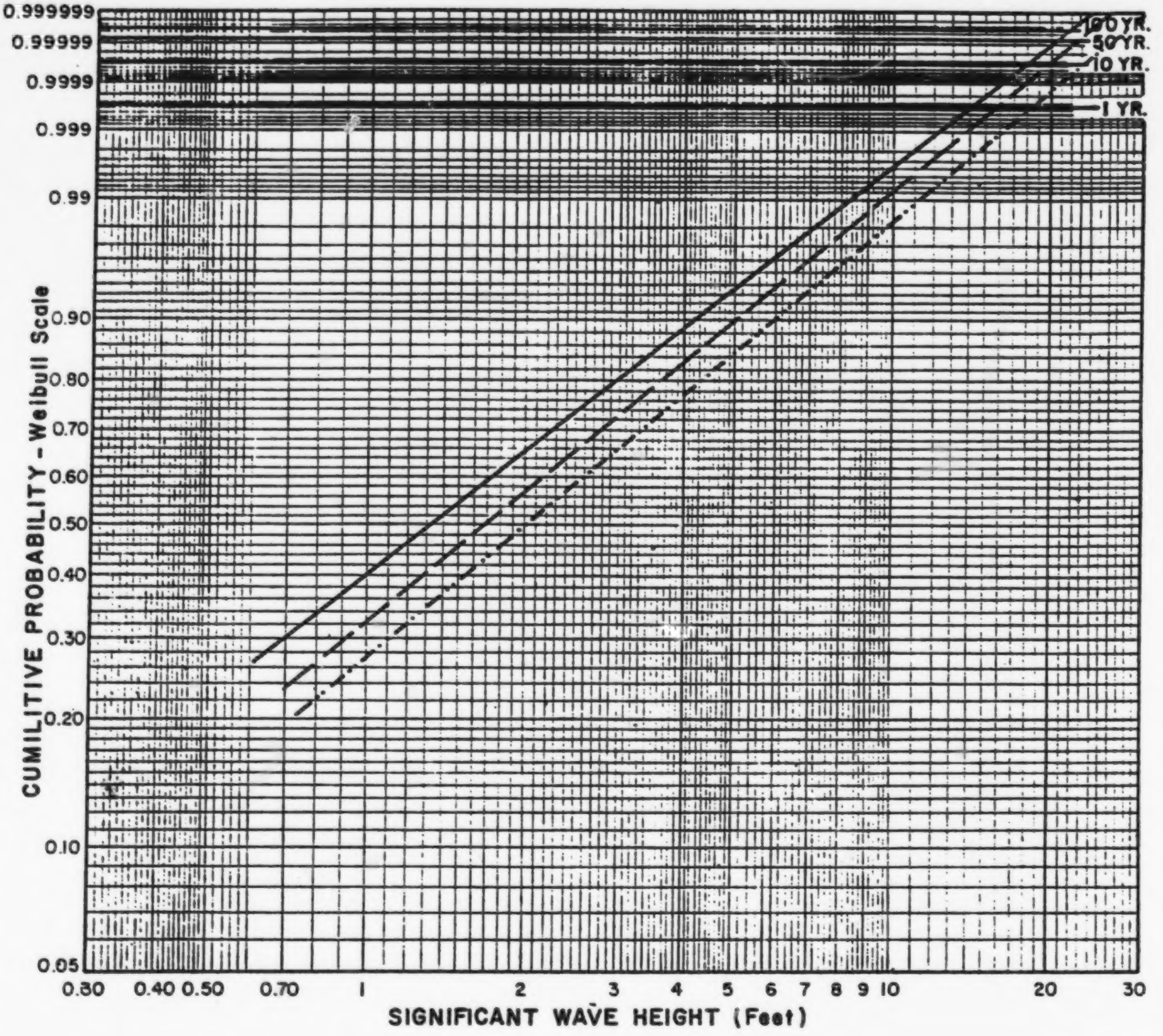
Also, the wave climate is a function of what is known as an overwater/overland (UW/UL) factor. UW/UL factors vary depending on air temperatures, water temperatures, wind speeds and differences in frictional effects created by land and water. For the purposes of this preliminary investigation, a UW/UL factor of 1.1 was assumed. This factor is considered conservative under extreme wind conditions.

A.3.4 Deep Sea Wave Climatology

Two sources of deep sea wave climatology were used for this preliminary investigation.

The first was based on previous Eastern Designers & Company Limited's Bay of Fundy studies which involved installation of 3 wave riders (4). The wave riders were installed offshore from Lorneville, Pt. Lepreau and Coleson Cove. The results of the analysis of the recorded data are shown on the Weibull Extrapolation Plot (Figure A.7). Based on these extrapolation curves, the following significant wave sea states would exist for the following return periods.

Once in 1 year	4.8 m (15.7 feet)
Once in 10 years	6.1 m (20.0 feet)
Once in 25 years	6.6 m (21.6 feet)



WEIBULL PLOT-TINER PT. & PT. LEPREAU

——— TINER POINT ALONE

— — TINER AND LEPREAU COMBINED

-··-·· LEPREAU ALONE

FIG. A.7

The above wave climate, of course, only applies to the region east of the Fundy Isles and may in fact not directly affect the structures in the locations under study.

Secondly, based on the wind climatology referred to in Sub-Section A.3.3 of this report and the fetch lengths available, preliminary wave hindcasting was performed both for the easterly and westerly sides of the Fundy Isles using the Sverdrup-Munk-Bretschneider method of analysis (2). This analysis resulted in the following preliminary deep sea wave climate.

Return Period	Easterly Side			Westerly Side		
	Fetch Direction	Significant Height (Hs)	Period	Fetch Direction	Significant Height (Hs)	Period
Once in 25 years	SE	6.7 m	10 sec	W.N.W.	3.0 m	6.3 sec

A.3.5 Near Shore Waves

Near shore waves (as associated with the design of shore connected structures) are normally determined by computerized wave refraction/ diffraction analysis. However, owing to the presence of such a large number of islands, varying bathymetry, etc., in this area, such an analysis would be useless, particularly for the east side of the West Isles.

For the purpose of this preliminary investigation, a refraction/ diffraction coefficient of Kr.Ks = 0.4 was assumed for easterly waves. For westerly waves, no reduction in wave height was assumed as there could be offsetting effects due to shoaling and possibly flume action. Based on these assumptions, design waves in the order of 2.7 m to 3.0 m from either direction could attack the proposed structures.

A.3.6 Preliminary Design Wave and Current Data

The following represents the selected preliminary significant design wave characteristics used for the conceptual design of proposed new causeways and protective structures for new ferry terminals. It is clearly understood that further hindcasting and model investigations would be required to verify these preliminary values.

Significant Wave Height .... 3 m
Wave Period .... 7 to 10 sec.

For conceptual design purposes, the following preliminary design current data were selected:

Letete Passage .... 3.66 m/sec. (12.0 ft./sec.)
Little Letete & Doyles/Pendleton Passage . 1.68 m/sec. (5.5 ft./sec.)

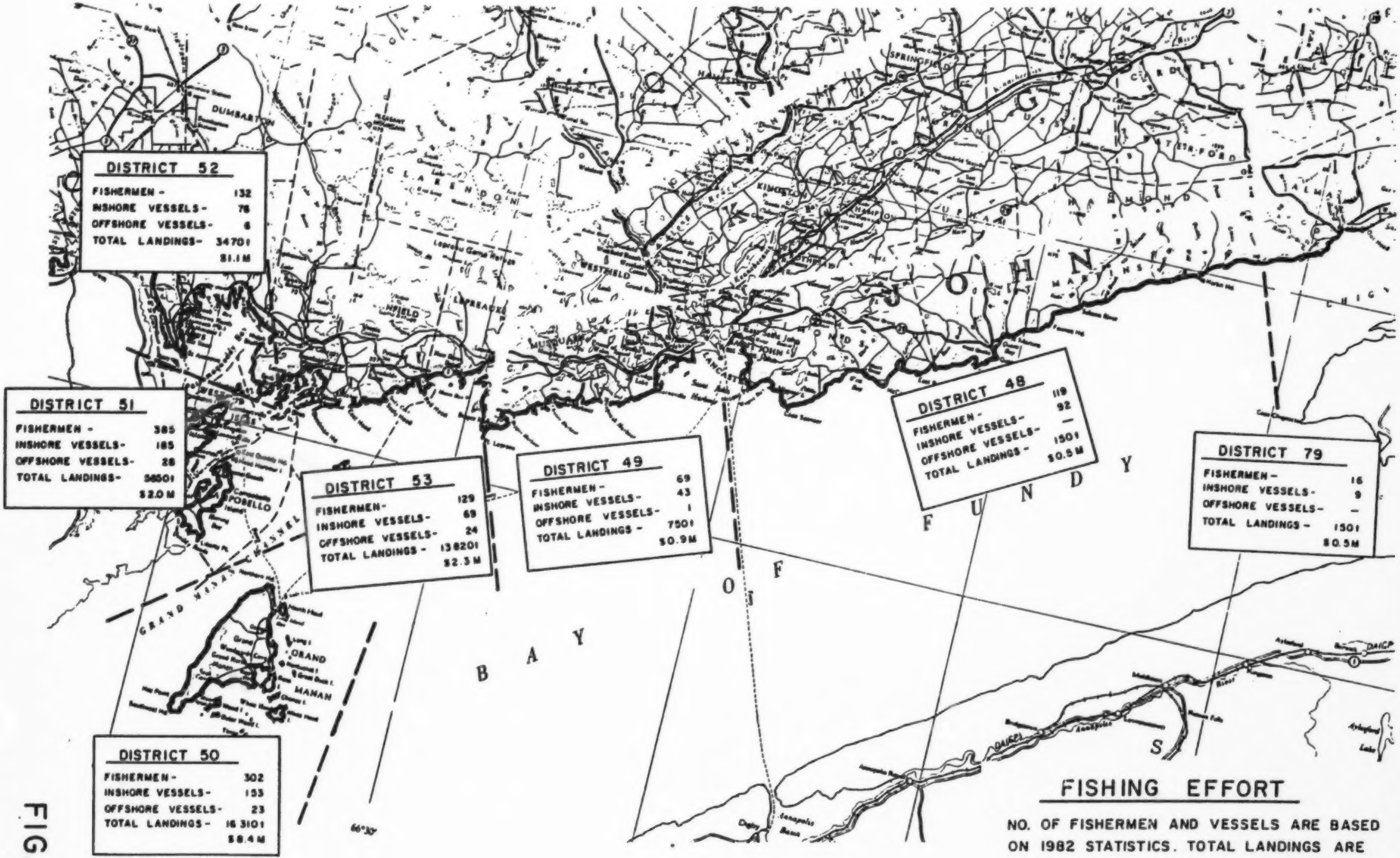
A.4 Impact on Resource Industry

The Passamaquoddy Fisheries Region is divided into Districts 51 and 52 with District 51 comprising Deer Island and Campobello Island. As indicated on Figure A.8, the local fishery resource industry which includes upwards of 517 full-time fishermen, 261 inshore vessels and 34 offshore vessels, generates revenue in excess of $3.1 M/annum (1). Although not all of the industry is concentrated in the Fundy Isles Region, it is obvious that the value of the resource in the Region itself is extensive.

The following is a statement contained in the Terms of Reference for "A Study to Assess The Feasibility of Establishing a National Marine Park In the West Isles, New Brunswick".

> "resource conservation measures considered will have to be consistent with the objectives of the Department of Fisheries and Oceans. In addition, it is the position of New Brunswick that there can be no adverse impacts on the fishery."

Although reports concerning the Passamaquoddy Tidal Power Project (12) inferred that closure of the passages between the various Islands would


DISTRICT 52
FISHERMEN - 132
INSHORE VESSELS- 76
OFFSHORE VESSELS- 6
TOTAL LANDINGS- 3470 t
$1.1 M
DISTRICT 51
FISHERMEN - 385
INSHORE VESSELS- 185
OFFSHORE VESSELS- 28
TOTAL LANDINGS- 5650 t
$2.0 M
DISTRICT 53
FISHERMEN- 129
INSHORE VESSELS- 69
OFFSHORE VESSELS- 24
TOTAL LANDINGS - 13820 t
$2.3 M
DISTRICT 49
FISHERMEN - 69
INSHORE VESSELS- 43
OFFSHORE VESSELS- 1
TOTAL LANDINGS - 750 t
$0.9 M
DISTRICT 48
FISHERMEN - 119
INSHORE VESSELS- 92
OFFSHORE VESSELS- —
TOTAL LANDINGS - 150 t
$0.5 M
DISTRICT 79
FISHERMEN - 16
INSHORE VESSELS- 9
OFFSHORE VESSELS- —
TOTAL LANDINGS - 150 t
$0.5 M
DISTRICT 50
FISHERMEN- 302
INSHORE VESSELS- 153
OFFSHORE VESSELS- 23
TOTAL LANDINGS- 16310 t
$8.4 M
DUMBARTON
CLARENDON
WESTFIELD
SPRINGFIELD
KINGSTON
SAINT JOHN
LANCASTER
MUSQUASH
LEPREAU
PENNFIELD
CAMPOBELLO
GRAND MANAN
GRAND MANAN CHANNEL
BAY OF FUNDY
66°30'

FISHING EFFORT

NO. OF FISHERMEN AND VESSELS ARE BASED ON 1982 STATISTICS. TOTAL LANDINGS ARE BASED ON 1983 STATISTICS AND ARE ROUNDED TO THE NEAREST 10 TONNES AND NEAREST $ 0.1 M.

Fig. 5.8

FIG. A.8

have no deleterous effects on the fishing industry, it is our opinion, the opinion of officials with the Fisheries and Oceans Biological Research Station in St. Andrews and the fishermen themselves that closure of passages (particularly between McMaster Island and Pendleton Island) would have serious negative impacts on the fishing industry.

The following statements were recorded from officials of the Biological Research Station concerning the effects of the potential causeway - ferry link to Deer Island as outlined in an earlier documents by Fenco (10) and the Department of Transportation (25):

1). Blockage of Pendleton Passage, Little Letete Passage, and parts of Letete Passage would dramatically alter currents in The Irish Channel and elsewhere and have profound and lasting effects on the efficiency of fishing weirs. It is estimated that at least 25 herring weirs would be affected.

2). Little Letete Passage is regularly used by fishing and recreational craft. Closure could add 4 miles steaming for vessels entering Passamaquoddy Bay from Deer Island ports.

3). There would be an increase in water velocity in Letete Passage with commensurate increase in overfalls and whirl pools.

4). Ship Harbour is a perfect site for aquaculture activities and should not be used for vehicular transport when other options are available.

5). There would be interference with the movement of fish in an out of Passamaquoddy Bay.

6). If the Fenco routing (10) is followed, all water crossings should be by bridge, allowing existing commercial and recreational vessels to transit currently navigable passages.

7). Any potential Letete Passage cable ferry should run from Cook Island, east of the power line so as to preserve Ship Harbour as an aquaculture site.

8). Passage closures will affect currents and productivity in the area proposed for the marine park.

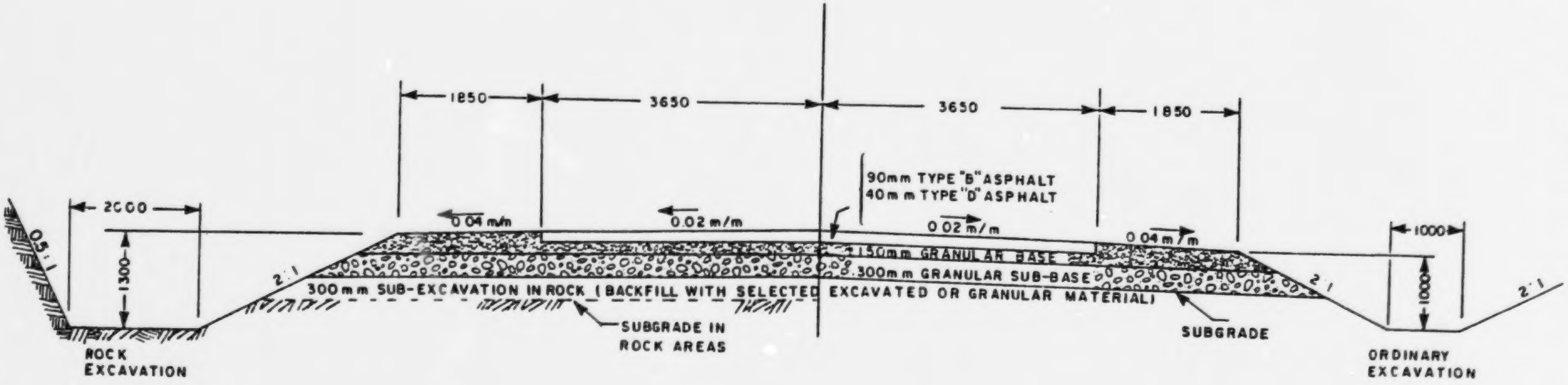
Although exception may be taken with some of the above statements, it does seem conclusive that the fishing industry would be adversely effected if the passageways were closed between Deer Island and Pendleton Island and between Pendleton Island and McMaster Island. For certain, the herring fishery would be affected. The degree to which the other fisheries would be affected would require detailed assessment. However, several references (9)(19)(26) clearly point out that the existing currents are essential to the industry in that the area acts as a huge "nutrient food pump" which is critical to the richness of the resource.

Based on the above, it is evident that causeway structures should not be constructed between McMaster and Pendleton Islands; nor between Pendleton and Deer Island without further detailed environmental impact studies. For these reasons, it was concluded that bridge structures should be employed for any potential crossing between McMaster and Pendleton Islands and either a full bridge or a partial causeway/bridge structure between Pendleton and Deer Islands.

A.5 Conceptual Highway Design

For the purposes of this preliminary investigation, a cross-section of the highway as illustrated on Figure A.9 was used.

With respect to highway alignment, a routing was selected based on available mapping which appeared to reasonably suit the topography although no detailed analysis was performed (see Figure A.10). Other alternatives investigated are also shown as dotted lines on Figure A.10.


1850
3650
3650
1850
90mm TYPE "B" ASPHALT
40mm TYPE "D" ASPHALT
2000
1300
0.5:1
0.04 m/m
0.02 m/m
0.02 m/m
0.04 m/m
150mm GRANULAR BASE
300mm GRANULAR SUB-BASE
300mm SUB-EXCAVATION IN ROCK (BACKFILL WITH SELECTED EXCAVATED OR GRANULAR MATERIAL)
2:1
2:1
2:1
1000
1000
SUBGRADE IN ROCK AREAS
SUBGRADE
ROCK EXCAVATION
ORDINARY EXCAVATION

TYPICAL ROADWAY SECTION

NORMAL CROWN

FIG. A.9

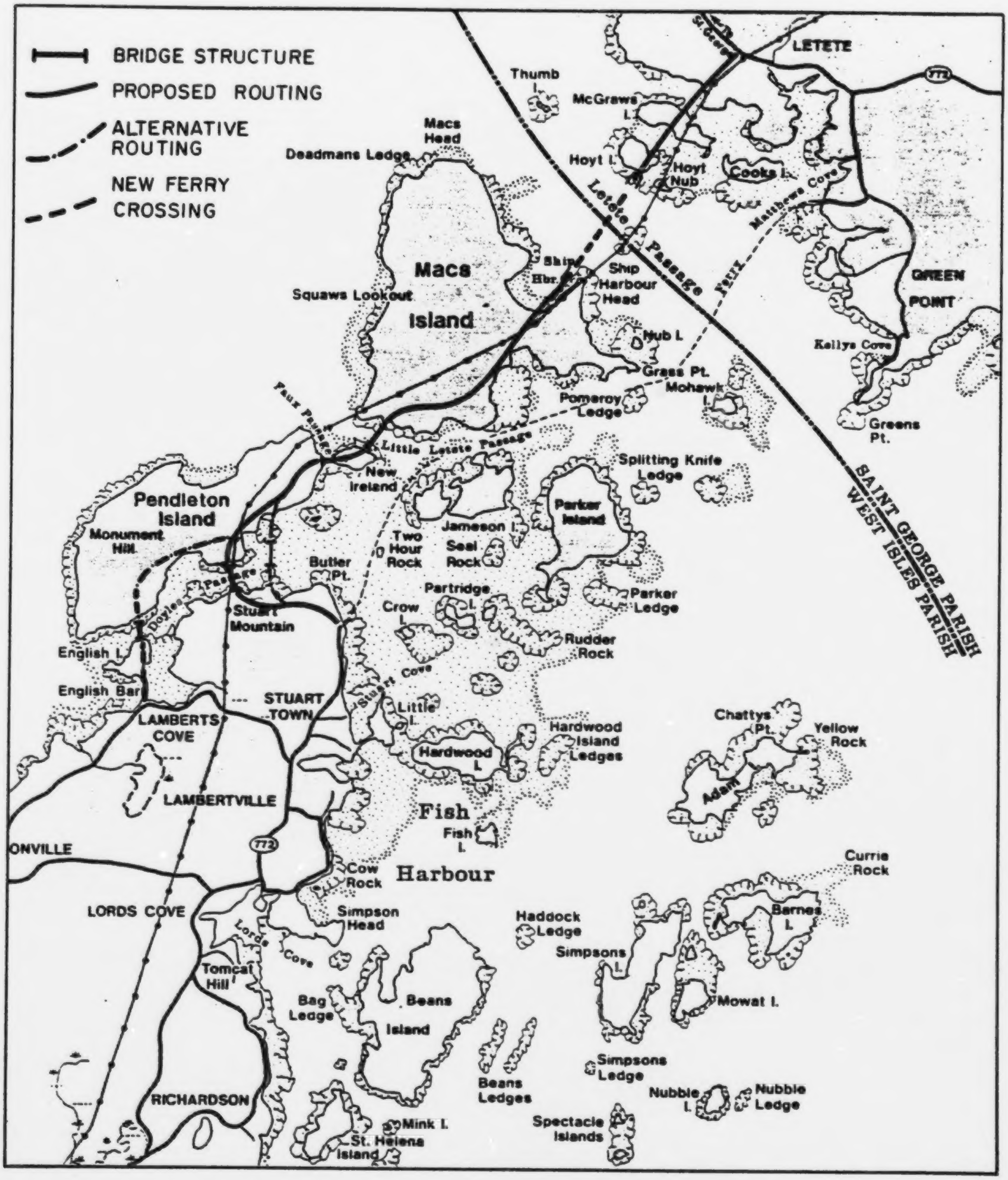

BRIDGE STRUCTURE
PROPOSED ROUTING
ALTERNATIVE ROUTING
NEW FERRY CROSSING
LETETE
772
Thumb I.
McGraws I.
Macs Head
Deadmans Ledge
Hoyt I.
Hoyt Nub
Cooks I.
Matthews Cove
Letete Passage
Ship Hbr.
Ship Harbour Head
Macs Island
Squaws Lookout
GREEN POINT
Ferry
Nub I.
Kellys Cove
Grass Pt.
Mohawk I.
Pomeroy Ledge
Greens Pt.
Faux Passage
Little Letete Passage
New Ireland
Splitting Knife Ledge
Pendleton Island
Monument Hill
Parker Island
Two Hour Rock
Jameson I.
Seal Rock
Butler Pt.
Doyles Passage
Partridge I.
Parker Ledge
Crow I.
Stuart Mountain
Rudder Rock
English I.
SAINT GEORGE PARISH
WEST ISLES PARISH
Stuart Cove
English Bar
STUART TOWN
Little I.
LAMBERTS COVE
Hardwood I.
Hardwood Island Ledges
Chattys Pt.
Yellow Rock
Adam
LAMBERTVILLE
Fish
Fish I.
ONVILLE
772
Cow Rock
Harbour
Currie Rock
LORDS COVE
Simpson Head
Haddock Ledge
Barnes I.
Lords Cove
Simpsons I.
Tomcat Hill
Bag Ledge
Beans Island
Mowat I.
Simpsons Ledge
Beans Ledges
Nubble I.
Nubble Ledge
RICHARDSON
Mink I.
Spectacle Islands
St. Helens Island

FIG. A.10

Based on the selected alignment and the cross-section referred to above, preliminary quantity take-offs were performed and capital cost estimates prepared.

A.6 Conceptual Breakwater/Causeway Design

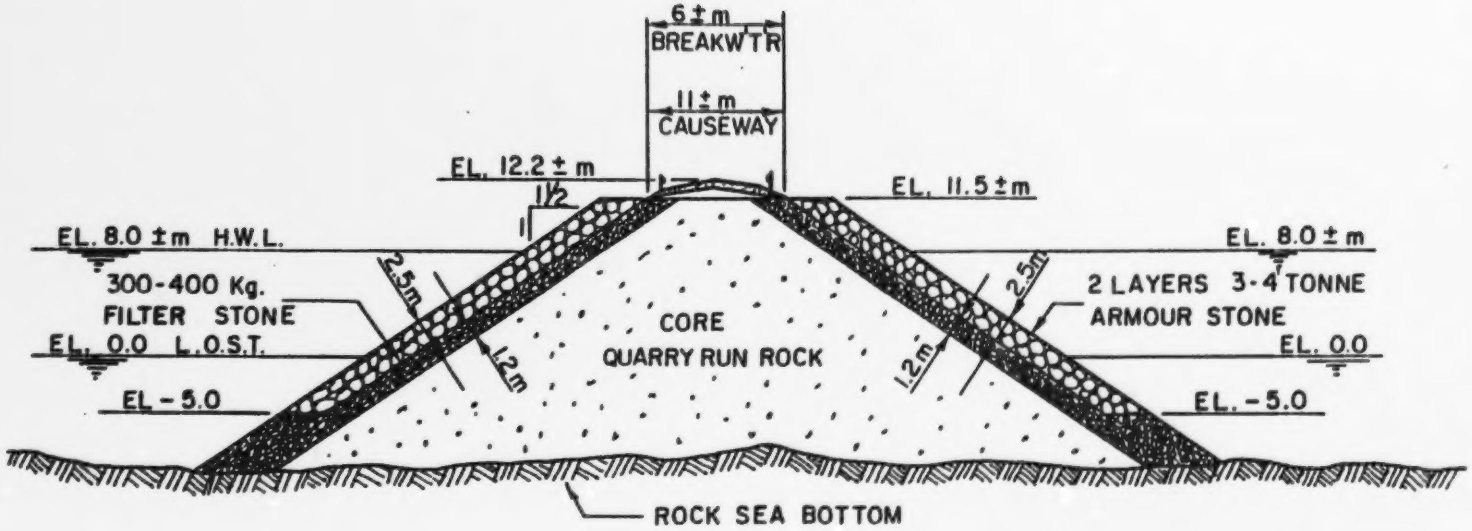
A breakwater/causeway cross-section as indicated on Figure A.11 was developed based on the assumed design wave height and current velocities outlined in Subsection A.3.6. The minimum elevation of the subgrade on the causeway of +11.5 m is approximately 3.5± m above high water level. At this elevation, minimal wave overtopping should occur.

The armour stone protection has been proportioned assuming 3 m waves on either side of the breakwater/causeway. The core of the breakwater/causeway would be constructed from quarry run rockfill from the local area with the size dependent on the currents. Side slopes of 1 1/2H:1V on the breakwater/causeway were chosen assuming that this would be the natural slope of end dumped rock fill. It was assumed the base of the breakwater/causeway would rest on solid rock foundation. Armour stone would be individually placed by crane for stability reasons.

As indicated in Section A.4 of this Report, although the closure of Little Letete Passage and Pendleton Passage by causeways would not significantly restrict the flow of the tide in and out of Passamaquoddy Bay, it would have a major and detrimental effect on the fishing industry. As such, closure should not be contemplated in this passage.

Partial construction of a causeway between Pendleton Island and Deer Island does appear to be a solution worthy of further investigation. For the purposes of this investigation, the causeway would have to be designed for flows in the 1.68 m/sec. (5.5 ft./sec.) range. Based on this velocity, it was calculated that the minimum size core material should be in the 30 to 40 kg range.

Breakwaters constructed in Letete Passage would be subjected to design flows of 3.66 m/sec. (12.0 ft./sec.) Based on currents of this magnitude,


6 ± m
BREAKWTR
11 ± m
CAUSEWAY
EL. 12.2 ± m
1½
1
EL. 11.5 ± m
EL. 8.0 ± m H.W.L.
300-400 Kg.
FILTER STONE
2.5m
EL. 8.0 ± m
2.5m
2 LAYERS 3-4 TONNE
ARMOUR STONE
EL. 0.0 L.O.S.T.
1.2m
CORE
QUARRY RUN ROCK
1.2m
EL. 0.0
EL -5.0
EL. -5.0
ROCK SEA BOTTOM

BREAKWATER/CAUSEWAY SECTION

FIG. A.11

it was calculated that the minimum size core material should be in the 3 000 to 4 000 kg range. As such, these breakwaters would be very expensive as standard "run of quarry" material could not be used in the core without excessive losses during construction.

A.7 Ferry Operation

As previously noted in Section 4.3 of this report, Marine Architects were consulted with respect to the technical feasibility of incorporating a cable type ferry system between Hoyt Island and Ship Harbour on McMaster Island (See Figure A.10).

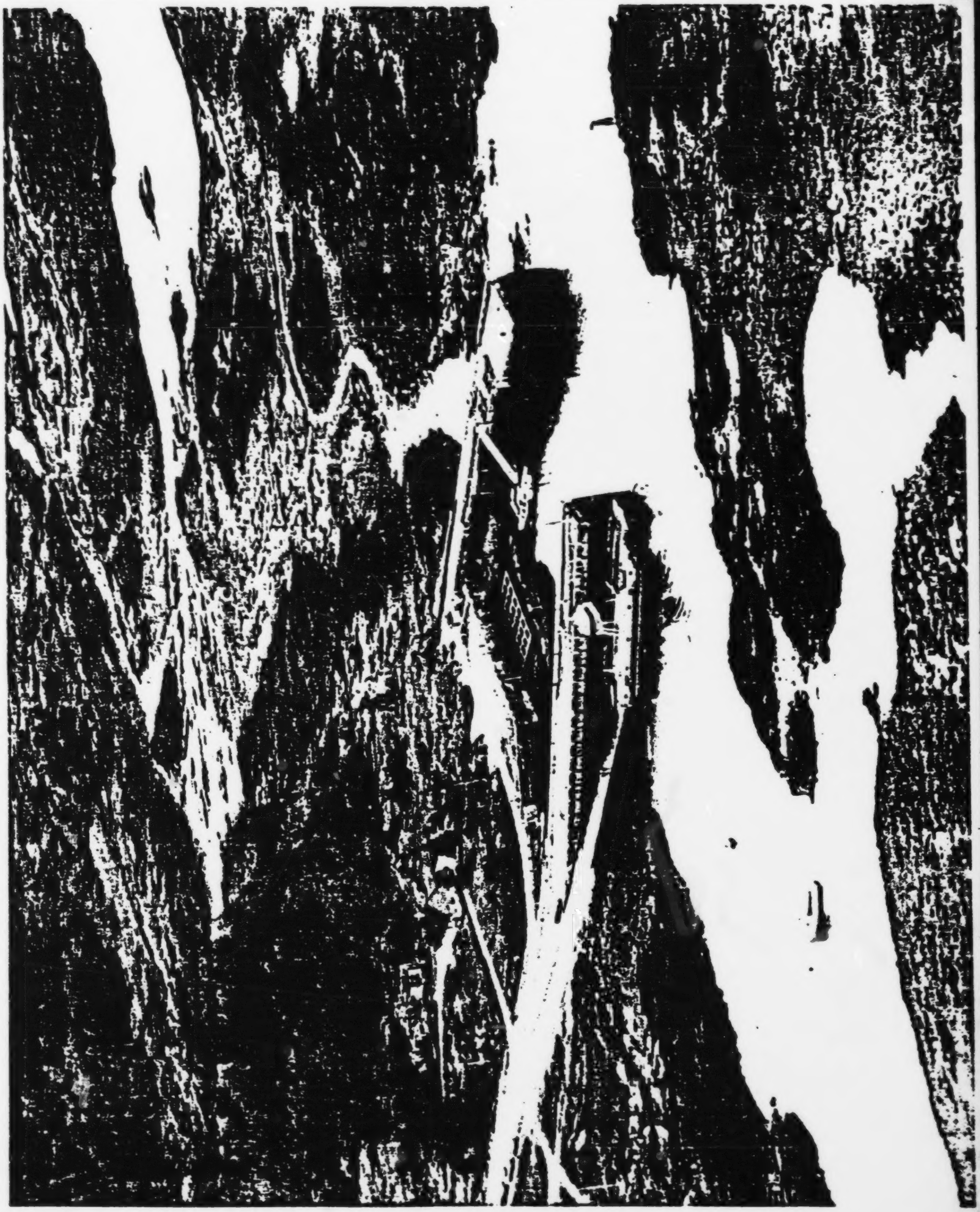
Based on the length of the crossing (approximately 1 km) and a design current velocity of 3.66 m/sec (12 ft./sec.), the Naval Architects concluded that a 125± mm (5± in.) cable would be required. The current force on the ferry would also require 3 000± HP side thrusters to compensate for lateral current forces. Due to these impracticalities, use of a cable ferry was ruled out in favour of conventional self-propelled ferry alternatives.

The following is a brief description of the proposed ferry's characteristics:

No. of Cars	Length	Breadth	Depth	BHP	Cost
24	45.7 m (150 ft.)	10.0 m (32.8 ft.)	2.4 m (8 ft.)	2 @ 435	$4.1 M

A.8 Conceptual Ferry Landing Design

For the purpose of this preliminary investigation, it was assumed that the requirements for new ferry landings would be similar to the existing type of facility at Stuart Town (see Photos No. 1 and No 2). It was assumed



LETETE FERRY TERMINAL
MAINLAND

Photograph No. I

BUTLER POINT FERRY TERMINAL
DEER ISLAND

Photograph No. 2

that the ferry landing would consist of a timber crib structure running out from shore approximately 125 m from the highwater mark. The vehicles would drive on to the ferry by means of a ramp.

The proposed new ferry landing on Hoyt Island would require breakwater protection on two sides. Alternatively, further detailed studies could indicate blasting out a harbour from the rock outcropping may be more economical.

The location of the landing at Ship Harbour has been assumed because of the sheltered nature of this location. However, as noted in Section A.4 of this report, this area is considered by Fisheries experts as a prime location for aquaculture activities. No detailed survey work was carried out as part of this investigation to locate the optimum site for any ferry terminals nor were any detailed investigations performed to determine the most cost-effective configuration or type of structure.

A.9 Conceptual Bridge Structures

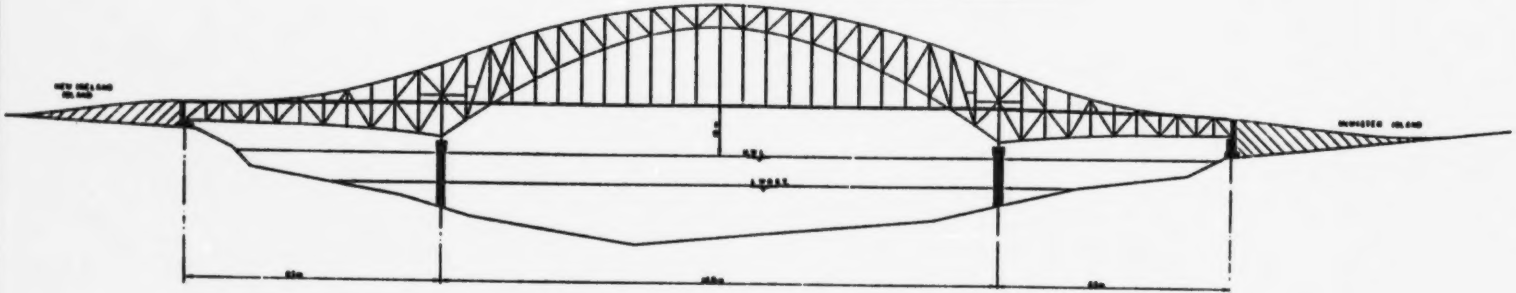
Constructing bridge structures between McMaster and Pendleton Island and Pendleton and Deer Island poses major problems.

A direct crossing between McMaster and Pendleton Island would involve a 405± m crossing over a 30± m depth of water (at HWL) with a main span 250± m in length. Obviously, such a structure would be extremely difficult to construct and does not appear worthy of further investigation.

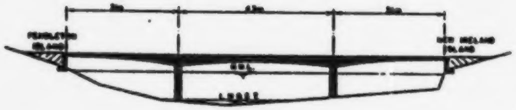
Alternatively, the crossing between McMaster and Pendleton could be made via New Ireland Island. This would result in two structures having spans of 290± m and 105± m and would appear to be more economical than a single crossing. This is due to the fact that the main span could be reduced from 250± m (for a single crossing) to spans of 160± m and 43± m respectively. (See Figure A.12). In both alternatives, consideration would probably have to be given to vessel clearances under the structures.

PENDLETON ISLAND
McMASTER ISLAND
H.W.L.
L.W.O.S.T.

LITTLE LETETE PASSAGE


NEW IRELAND ISLAND
McMASTER ISLAND
H.W.L.
L.W.O.S.T.

LITTLE LETETE PASSAGE


PENDLETON ISLAND
NEW IRELAND ISLAND
H.W.L.
L.W.O.S.T.

FAUX PASSAGE

FIG. A-12

EASTERN DESIGNERS & COMPANY LIMITED
Engineering Consultants
P.O. Box 613 FREDERICTON, N.B. 106 Prospect St

McMASTER IS. TO PENDLETON CROSSING

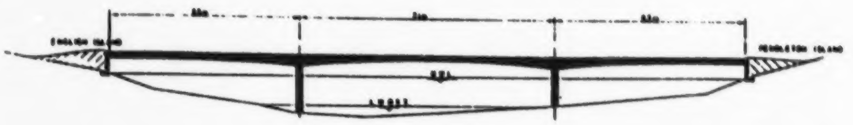
Three conceptual alternative locations were investigated for the crossing between Pendleton and Deer Island (See Figure A.13). These included a crossing to English Island and Lamberts Cove (177± m crossing) over a depth of water of 10± m (at HWL), a 190± m crossing 650± m west of Butler Point over a depth of water of 10± m (at HWL) and a 590± m crossing 400± m west of Butler Point over a depth of water of 10± m (at HWL). As indicated on Figure A.13, the latter crossing could be made by the use of a series of 70± m spans with an interior span of 100± M or alternatively, by the use of a combination causeway/bridge structure, in which case the bridge could consist of 2 - 66 m spans and an interior span of 88 m. Further studies would, of course, be required to substantiate the feasibility of restricting the tidal flow of water as proposed by this alternative.

For the purposes of this investigation, the second alternative (a 190± m crossing located 650± m west of Butler Point) was selected as it appeared to offer the most economical combination of bridge and highway costs.

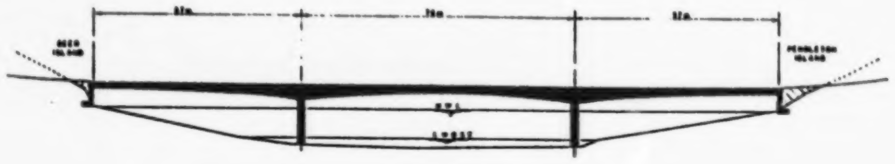
It is our understanding that vessel access would not be required through Pendleton Passage and as such the bottom of the structures were located 3± m above high water.

For conceptual purposes only, with the exception of the 290± m crossing between Pendleton and New Ireland islands, it was assumed that the superstructures would be constructed of continuous welded steel plate girders and/or steel box girders with conventional concrete decks. As indicated in Figure A.12, the Pendleton/New Ireland bridge was assumed to be a continuous truss structure.

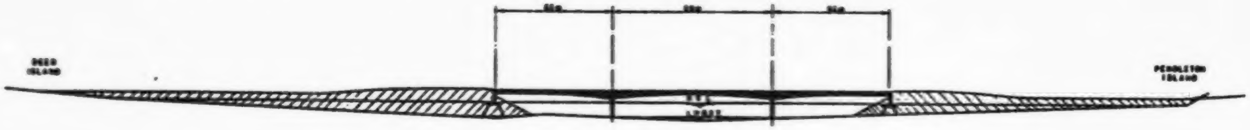
Due to the assumed presence of rock at shallow depths or complete lack of overburden, one solution for the substructures could be circular caissons socketed into the rock with conventional concrete cap beams spanning between the caissons.


ENGLISH ISLAND
PENDLETON ISLAND
H.W.L.
L.W.O.S.T.

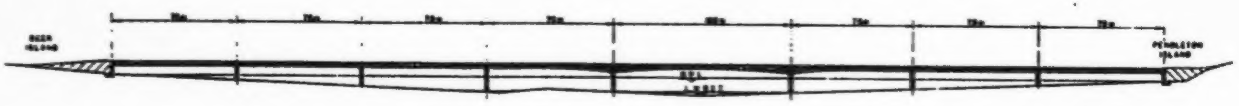
PENDLETON PASSAGE @ ENGLISH ISLAND


DEER ISLAND
PENDLETON ISLAND
H.W.L.
L.W.O.S.T.

PENDLETON PASSAGE 650m WEST OF BUTLER POINT


DEER ISLAND
PENDLETON ISLAND
H.W.L.
L.W.O.S.T.

PENDLETON PASSAGE 400m WEST OF BUTLER POINT


DEER ISLAND
PENDLETON ISLAND
H.W.L.
L.W.O.S.T.

PENDLETON PASSAGE 400m WEST OF BUTLER POINT

FIG. A-13

EASTERN DESIGNERS & COMPANY LIMITED
Engineering Consultants
P.O. Box [illegible] FREDERICTON, N.B. [illegible] Prospect St.

PENDLETON TO DEER ISLAND CROSSING

The preliminary "order of magnitude" costs of the various elements of a fixed bridge/causeway link between Deer Island, Pendleton Island and McMaster Island are summarized in Section A.2.

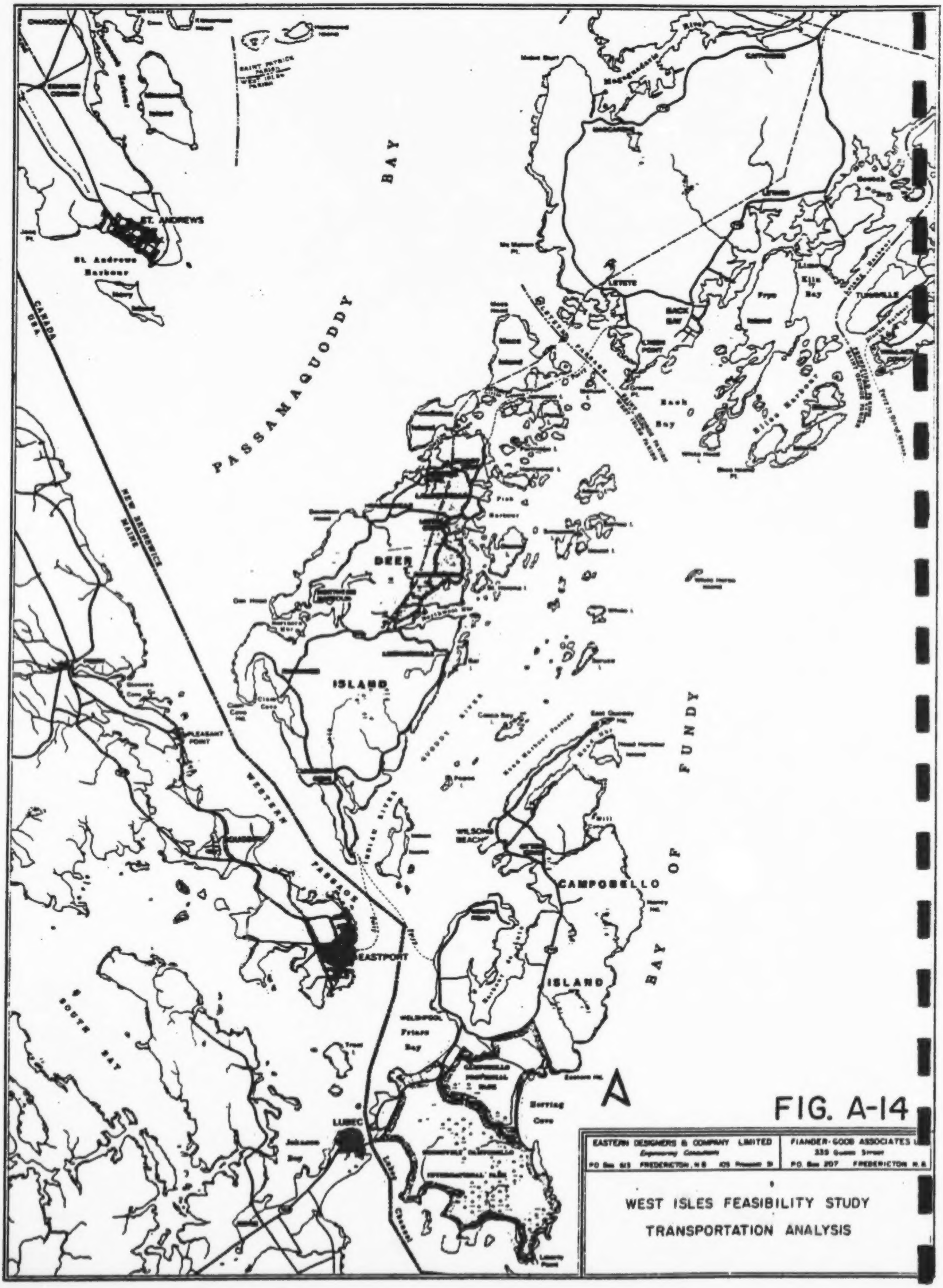

PASSAMAQUODDY BAY
ST. ANDREWS
St Andrews Harbour
CHAMCOOK
SAINT PATRICK PARISH
WEST ISLES PARISH
CANADA
U.S.A.
NEW BRUNSWICK
MAINE
LETETE
BACK BAY
Back Bay
Frye Island
Kiln Bay
Fish Harbour
DEER ISLAND
Clam Cove
PLEASANT POINT
WESTERN PASSAGE
INDIAN RIVER
QUODDY RIVER
WILSONS BEACH
CAMPOBELLO ISLAND
BAY OF FUNDY
EASTPORT
WELSHPOOL
Friars Bay
Herring Cove
LUBEC
Johnson Bay
Lubec Channel
SOUTH BAY
INTERNATIONAL PARK

FIG. A-14

EASTERN DESIGNERS & COMPANY LIMITED
Engineering Consultants
PO Box 613 FREDERICTON, N.B. 105 Prospect St

FIANDER-GOOD ASSOCIATES L
333 Queen Street
P.O. Box 207 FREDERICTON N.B.

WEST ISLES FEASIBILITY STUDY

TRANSPORTATION ANALYSIS

REFERENCES

REFERENCES

1.	Marine Service Centre Study, Bay of Fundy Region, New Brunswick, March, 1984	Eastern Designers & Company Limited
2.	Shore Protection Manual, Volumes I, II, III, Dept. of the Army Corps of Engineers, 1975	US Army, Coastal Engineering Research Centre
3.	Wind and Wave Climate Study for New Brunswick Electric Power Commission Point Lepreau Nuclear Power Plant Site, February, 1975. Unpublished	Eastern Designers & Company Limited
4.	Storm Damage Appraisal, N.B. Power's Coleson Cove CW Intake Breakwater, October, 1976. Unpublished	Eastern Designers & Company Limited
5.	Current Measurements in Passamaquoddy Bay and the Bay of Fundy, 1957 and 1958, Oct. 1958	W. D. Forrester
6.	Memorandum from D. J. Scarratt, Division Coordinator to Harris Hord, Habitat Coordinator, May, 1983	Dept. of Fisheries and Oceans
7.	Flow of Water in the Passages of Passamaquoddy Bay Measured by the Electromagnetic Method, Feb. 1962	R.W. Trites and D.G. MacGregor, Fisheries Research Board of Canada

REFERENCES (Cont'd)

8.	Physical Oceanography of the Quoddy Region	Ronald W. Trites and Christopher J. Garrett
9.	A Comparative Resource Analysis of the Deer Island and Grand Manan Archipelagos, Bay of Fundy, Sept., 1976	Marine Research Associates (Arthur A. MacKay, Director)
10.	Deer Island Causeway, June, 1972	Foundation of Canada Engineering Corporation Limited
11.	Probable Effects of Proposed Passamaquoddy Power Project on Oceanographic Conditions, December, 1960	R.W. Trites, Fisheries Research Board of Canada
12.	Investigation of the International Passamaquoddy Tidal Power Project, October, 1959	The International Passamaquoddy Engineering Board
13.	Submission to The International Joint Commission on the Passamaquoddy Tidal Power Plant, April, 1960	Connors Brothers Limited
14.	Summary of Physical, Biological, Socio-Economic and other factors relevant to potential oil spills in the Passamaquoddy Region of the Bay of Fundy, March, 1974	Department of the Environment
15.	Comments on Flushing Time for Passamaquoddy Bay and Wind-Generated Waves in the Quoddy Region	R.W. Trites, Bedford Institute of Oceanography

REFERENCES (Cont'd)

16. National Marine Parks Draft Policy, August, 1983	National Parks System Division, Parks Canada
17. National Marine Park Concept West Isles, New Brunswick, Pilot Study, March, 1983 (Summary Document)	Parks Canada/Tourism New Brunswick
18. Fundy Isles Region, Tourism Industry Development Plan. October, 1976	Airphoto Analysis Associates Consultants Limited
19. A Comparative Analysis of the Deer Island and Grand Manan Archipelagos, June, 1977	Marine Studies Section, Parks System Planning Division, National Parks Branch, Parks Canada
20. Fundy Coastal Zone Study, Bay of Fundy, N.B., March, 1982	Hunter and Associates
21. Bay of Fundy Resource Inventory Back Bay, Letang Inlet, March, 1978	Marine Research Associates
22. Investigation of the International Passamaquoddy Tidal Power Project, April, 1961	International Joint Commission International Passamaquoddy Engineering and Fisheries Board
23. Coastal Zone Management Study, Bay of Fundy, N.B., March 1982	Hunter and Associates
24. The Proposed West Isles National Marine Park Socio-Economic Impact Study	DPA Consulting Ltd.

REFERENCES (Cont'd)

25. Internal Study, Deer Island Ferry Service	Department of Transportation
26. Marine and Coastal Systems of the Quoddy Region, New Brunswick, 1983	Department of Fisheries and Oceans